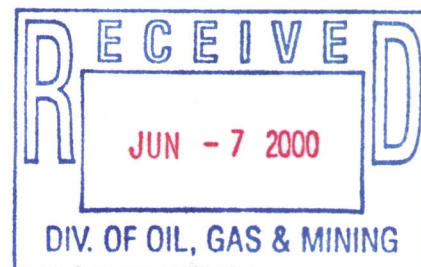


Kennecott Barneys Canyon Mining Corp
8200 South 9600 West
P.O. Box 311
Bingham Canyon, UT 84006-0311
(801) 569-7000
FAX (801)569-7190

m/35/009

June 7, 2000

Mr. Wayne Hedberg, Permit Supervisor
Minerals Reclamation Program
Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
PO Box 145801
Salt Lake City, Utah 84114-5801



Subject: Redline Copy of Revised Barneys Canyon Reclamation Plan

Dear Mr. Hedberg:

Attached is a redline copy of the revised Barneys Canyon Reclamation Plan that was requested by your office in a letter dated March 13, 2000. Text that is proposed for removal is struck out with a single line, and text that is added is highlighted. Barneys Canyon will incorporate your comments when they are received, and will complete a final version of this plan without redlines and that is formatted uniformly.

Please give me a call at 801-569-7110 if you have any questions or comments.

Sincerely,

Ray Gottling
Operations Manager
Barneys Canyon Mine

Attachment

June 7, 2000

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Sincerely,

Ray Gottling
Operations Manager
Barneys Canyon Mine

Attachment

M/35/009

MINING AND RECLAMATION PLAN

KENNECOTT CORPORATION

BARNEYS CANYON MINE

~~East Barneys Canyon Project~~

SUBMITTED TO UTAH DIVISION OF OIL, GAS AND MINING

June 7, 2000

**KENNECOTT BARNEYS CANYON MINING COMPANY
P. O. BOX 311
Bingham Canyon, Utah 84006-0311**

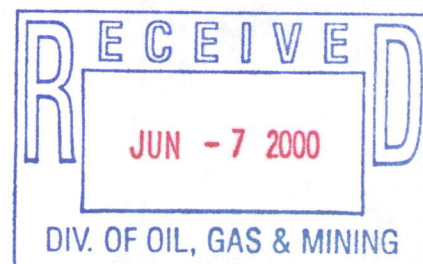


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1.0 INTRODUCTION

Kennecott Barneys Canyon Mining Company, operates an open pit gold mine and heap leach process facility known as the Barneys Canyon mine. The project mines and processes approximately 2,600,000 tons of ore per year at an average rate of 7,000 tons per day (TPD). The principal project components are the Barneys, Melco, East Barneys and BG North and South BC South open pit mines, and related mine waste dumps and a processing plant. The processing plant consists of screening, conveying, ore crushing and agglomerating facilities, a number of heap leach pads, a leachate processing plant and refinery, and offices and shops.

Kennecott submitted a Notice of Intent to Commence mining operations to the Division of Oil, Gas and Mining (DOGM) in February, 1988. The NOI was revised in September 1989, again in March 1994 December 1993 and in March 1997. This latest revision is being submitted to account for changes in the cover design of the sulfide waste rock repositories.

Kennecott commenced construction of the Barneys Canyon Mine in the third quarter of 1988 leading to gold production in the third quarter of 1989.

Kennecott obtained approval from DOGM in December 1992 to modify its Barneys Canyon mining operations beginning in the first quarter of 1993. The modification involved development and operation of two new open pit mines and expansion of the Melco open pit mine. Except for the addition of a sulfide flotation plant, the process plant facilities, ancillary facilities, and mine service facilities were not affected by the changes. The principal project components were the South BC South, the North BC South, and Melco open pit mines and related mine waste dumps and haulage roads. Pre-stripping of topsoil in the BC South area began in the fourth quarter of 1992 and mining commenced in February of 1993. The finalized version of a combined Notice Of Intent was submitted to DOGM in December 1993.

In 1997, Kennecott intends to modify modified its Barneys Canyon mining operations by expanding the size and depth of the North BC South and Melco pits, by creating a series of waste dumps north of the current Melco pit, by redesigning the permitted 7200 dump to improve drainage and by constructing a haul road from the north side of the expanded Melco Pit to the North BC South pit (Plate II-C).

This latest The 1997 revision includes also included the East Barneys project consisting of a small pit and the associated haul roads. The East Barneys waste will be was taken to the Barneys Canyon Pit as backfill. Prestripping for this project is to begin began in the first quarter of 1997.

Kennecott requests that its existing permit (reference file number M/035/009) be amended in accordance with the additional operating and reclamation plans presented herein. This latest revision incorporates changes in the design of the sulfide repository caps that have already been approved by the State Division of Water Quality and the State Division of Oil

Gas and Mining

1.1 Location

The project area is located on the east flank of the Oquirrh Mountains in Salt Lake County, Utah, approximately 3 miles northwest of Copperton, Utah. The project location is shown on the location map, Figure 1.1-1. Project facilities will be ~~are~~ located as follows:

Main Access Road	Township 2 South, Range 2 West, Sections 31 and 32 Township 3 South, Range 2 West, Sections 3, 4, 5, and 6
Plant Site and Barneys Mine Pit and Dump	Township 2 South, Range 2 West, Section 31 Township 2 South, Range 3 West, Section 36 Township 3 South, Range 3 West, Section 1
Melco Mine Pit and Dump	Township 3 South, Range 3 West, Sections and Access Road 1, 2, 3, and 11.
South BC South, North BC South	Township 3 South, Range 3 West, Section 1 and 2 Township 3 South, Range 3 West, Section 1 and 2
BC South Dump	Township 3 South, Range 3 West, Section 1
Melco Mine Pit and Dump and Access Road	Township 3 South, Range 3 West, Sections 1, 2, 3, 10, and 11.
Melco North Dumps	Township 3 South, Range 3 West, Sections 2 and 3 (northern 1/2). Township 2 South, Range 3 West, Sections 34 and 35 (southern 1/8).
Melco 7200 Dump	Township 3 South, Range 3 West, Sections 2 (southern 1/8) and 11 (northwest 1/4).
North Haul Road	Township 3 South, Range 3 West, Section 2 (northern 1/2).
East Barneys Pit	Township 3 South, Range 3 West, Section 1
Melco Sulfide Repository	Township 3 South, Range 3 West, Section 2
NBCS Sulfide Repository	Township 3 South, Range 3 West, Section 1 and 2

Project facilities are shown on the Project Facilities Map, Plates I-A & I-B (in pocket).

1.2 Land Ownership

1.2.1 Surface Ownership.

All land surface within the project disturbed area is owned in fee by Kennecott Barneys Canyon Mining Company. A third party, Calvin J. Spratling and William Max Spratling originally owned the roadway and right of way that provided access to a television broadcast tower owned by Station KCPX, located in the northeast quarter of the northeast quarter of Section 34, Township 2 South, Range 3 West. Kennecott, through a land exchange arrangement, has provided an alternate access road to the TV tower site.

Kennecott owns all land that will be disturbed and all land adjacent to the proposed disturbed area. The Surface and Mineral Ownership map (Figure 1.2-1) shows all surface land ownership within an approximate 21-square-mile area around the project site. The names and addresses of adjacent surface landowners whose properties are shown on the land map are listed in Table 1.2.1.

Table 1.2-1 Surface Land Ownership

Name	Address	Comments
Federal Government	BLM - Salt Lake District Office 2370 South 2300 West Salt Lake City, UT 84119	Surface ownership on western boundary of area. Kennecott control mineral rights via unpatented mining claims.

1.2.2 Subsurface Ownership.

Subsurface land or mineral rights ownership within and immediately adjacent to the ore bodies is also shown on the Surface and Mineral Ownership map (Figure 1.2-1). The names and addresses of the subsurface owners, other than Kennecott, are listed in Table 1.2.2. Kennecott leases mineral rights to the Barneys Canyon deposit from the State of Utah.

Table 1.2-2 Subsurface Ownership

Name	Address	Comments
Leroy E. Everett	411 East 100 South Salt Lake City, UT 84111	Owns 4.17 % mineral interest in large tracts NE N and NW of the Barneys Canyon mine. Kennecott owns remaining 95.83% mineral interest and 100 surface.
Calvin J. Spratling	Star Route, Box 400 Pendleton, OR 87801	50% mineral interest east of the Barneys Canyon mine, shares ownership with Carla P. Spratling. Kennecott owns remainin 50% mineral interest and 100% surface.
Carla P. Spratling	Star Route Pendleton, OR 87801	50% mineral interest east of the Barneys Canyon mine, shares ownership with C. J. Spratling. Kennecott owns remainin 50% mineral interest and 100% surface.
State of Utah Division of State Lands and Forestry	3 Triad Center, #350 Salt Lake City, UT 84180	

State Lease for
Metalliferous Minerals:
Lease No. 27390, Sec.
36.T. 2S., R.3W.
Kennecott owns 100%
surface.
Barton Syndicate

c/o A. Park Smoot
Barton Syndicate Trust
765 East Three
Fountains Circle No. 33
Murray, UT 84107

Unpatented mining
claims and State Lease
for Metalliferous Mineral
SW of Melco. Under
lease to Kennecott.
Kennecott and Federal
Government own
surface.

William Max Spratling

Starr Valley
Deeth, NV
89823

50% mineral interest in
tract east of the Barney's
Canyon mine. Remain
50% mineral interest
owned by Kennecott.
Kennecott owns 100%
surface.

Richard & Mary L. Kehl

1022 Shields Lane
South Jordan, UT
84065

19/60 mineral interest in
patented claim NW of
Melco, shares ownership
with F. & J. Serassio, A.
Parsons, D. & J.L. Rudd,
and Quality for Animal
Life. Kennecott owns
100% surface.

Frank & Julin Serassio

1694 E. Juhlo St.
Sandy, UT 84092

39/100 mineral interest in
patented claim NW of
Melco, shares ownership
with above. Kennecott
owns 100% surface.

Alan Parsons

724 S. 300 E.
Salt Lake City, UT
84111

1/100 mineral interest in
patented claim NW of
Melco, shares ownership
with above. Kennecott
owns 100% surface.

Drew & Josephine Rudd

12014 S. Mill Ridge
Circle
Sandy, UT 84070

1/5 mineral interest in
patented claim NW of
Melco, shares
ownership with above.
Kennecott owns 100%
surface.

Quality for Animal Life

150 East 1300 South
Salt Lake City, UT
84115

5/60 mineral interest in patented claim NW of Melco, shares ownership with above. Kennecott owns 100% surface.

1.2.3 Surface and Mineral Ownership

Parcels for which combined surface and mineral rights are owned by the same individuals are also shown on the Surface and Mineral Ownership map (Figure 1.2-1). The names and addresses of these owners, other than Kennecott, are listed in Table 1.2-3.

Table 1.2-3. Surface and Mineral Ownership

Name	Address	Comments
Evelyn Harmon Est.	C/O Howard H. Haynes, Jr. 2830 E. St. Marys Way Salt Lake City, UT 84108	100 % ownership of small parcel north of the Barneys Canyon mine, shares ownership with E Daniels Est.
Edith Daniels Est.	C/O Howard H. Haynes, Jr. 2830 E. St. Marys Way Salt Lake City, UT 84108	100 % ownership of small parcel north of the Barneys Canyon mine, shares ownership with E Harmon Est.
Calvin J. Spratling	Star Route, Box 400 Pendleton, Oregon 87801	100% ownership of road corridor through project area, shares ownership with W. M. Spratling. Kennecott presently negotiating land swap

William Max Spratling

Starr Valley
Deeth, NV
89823

100% ownership of road corridor through project area, shares ownership with C. J. Spratling. Kennecott presently negotiating land swap.

Copperton Improvement District

208 South 400 East
Copperton, UT 84006

100 % ownership of water well sites east of Barneys Canyon mine.

1.3 Land Use

The lands in the project site are patent lands under the control of Kennecott. The principal land use at the project site-proper has been for wildlife habitat. The areas that will be developed are currently undeveloped and wildlife usage is relatively high, although recent exploration and mining activity has undoubtedly caused at least local changes in the level of wildlife usage. The wildlife in the area is discussed in Section 2.6. The lands are presently closed to public access and, consequently, little hunting occurs here. These lands also are leased for livestock grazing. An access road through the property allows access to the KCPX TV tower on the ridge adjacent to Harkers Canyon (Plate I-A). Land adjacent to the current project access road is under cultivation for wheat.

1.4 Existing Facilities

The locations of existing mine and processing facilities are shown on Plate 96-1. These facilities have been in place since completion of construction in 1989. Development of open pit mines, related mine waste dumps, and leach pads have been in accordance with the development plans approved by the Division. There are no other buildings, lakes or reservoirs within the project area or within 500 feet of it, except for lakes that have formed in the bottom of the Barneys and East Barneys pits. The locations of streams, springs, and wells are discussed in Sections 2.2 and 2.3. Powerline locations are shown on Plate II-A, the Pre-Disturbance Map. There are no other transmission lines in the project area.

1.5 Mineral Exploration

Kennecott commenced mineral exploration on the project in 1981, with drilling beginning in 1985. A total of 215 exploration drill holes ranging in depth from 35 to 976 feet were drilled using rotary reverse circulation and diamond core drilling machines. The Pre-Disturbance site Map, Plate II-A, shows the locations of exploration drill holes outside the mine development area. This map is Confidential. The locations of exploration drill holes have also been provided the Division in previous submittals of exploration Notices of Intent. Areas of more intensive drilling at the sites of the proposed open pits are outlined

on the map.

Exploration and delineation of the North BC South and South BC South deposits have been ongoing since began in 1988. Approximately 214 exploration drill holes defined the two deposits. Exploration drill hole locations were provided to the Division in previous submittals of exploration Notices of Intent and Mineral Exploration Progress Reports.

All drill holes have been ~~or will be~~ plugged according to regulations, unless they have been completed as piezometers. In addition to drilling, a number of trenches were dug with a backhoe, and access roads for drilling equipment were built with bulldozers.

Other exploration work consisted of geologic mapping and sampling.

Ongoing ~~Further~~ exploration ~~also has~~ identified a minable reserve in the East Barneys area. This is approximately 1200 feet south and east of the current entrance to the Barneys Pit. This reserve ~~contains~~ ~~contained~~ approximately 1.5m tons, consisting of nearly equal amounts of ore, alluvium overburden and rock overburden.

1.6 Utilities and Access

The entire plant site, warehouse, and truck shop are supplied with electricity from Kennecott's Utah Copper Division. The Facilities Layout and Operational Surface Water Management Plan map, Plate III-A, shows the location of the powerline. Propane for heating is supplied to the site via truck. Telephone service is supplied by ~~Mountain Bell~~ ~~U. S. West~~. Telephone service is brought to the site via the powerline or access road corridor.

Access to the project area is via an improved access road from Highway 48. The principal access to the Melco mine pit is via a graveled road from Barneys Canyon along the route shown on Plate III-A.

Two short segments of the Melco access road ~~will be~~ ~~were~~ realigned to allow for the construction of the North BC South and the South BC South pit.

A new haul road was constructed from the north side of the expanded Melco pit to the North BC South pit. This road ~~will provide~~ ~~provides~~ shorter ore and waste hauls for the duration of the Melco pit life thereby, reducing fuel consumption and PM10 emissions (Plate II-C).

Access to the East Barneys area ~~will be~~ ~~is~~ from a haul road currently used to access a permitted clay pit and topsoil stockpile. The road ~~will be~~ was widened to accommodate the mining equipment and ~~will be~~ reclaimed at the end of the project.

2.0 Site Description

2.1 Geology

2.1.1 Geologic Setting

The Barneys Canyon project area is located at the east edge of the Paleozoic core of the Oquirrh Mountains. The surficial geology of the project area is shown on Figure 2.1-1. The Oquirrh Mountains are composed principally of Pennsylvanian and Permian miogeoclinal sedimentary rocks with an aggregate thickness of more than 35,000 feet. The principal rock types are limestones and sandstones that were deposited cyclically.

The Barneys Canyon mine site is underlain by the Permian Kirkman-Diamond Creek and Park City Formations. The Melco pit lies near the contact of the Kirkman-Diamond Creek sandstone and orthoquartzite of the Freeman Peak Formation. These units are moderately to steeply dipping in directions ranging from northwest at Melco to north and northeast at Barneys Canyon. Structurally, the Kirkman-Diamond Creek and the Freeman Peak Formations are part of the footwall plate of the Oquirrh thrust fault (Figure 2.1-1). The Park City Formation occurs at the east side of the Barneys Canyon deposit and has been preserved in a down-faulted block, as shown on the geologic map (Figure 2.1-1). The rock units in the project area are exposed on the "nose" of the north-trending, north-plunging Copperton Anticline and vary in strike across the map (Figure 2.1-1). The stratigraphic units dip moderately to the northeast, north, and northwest. In addition to thrusting, the Paleozoic rocks have been broken by a number of northeast and north-trending, high-angle normal faults (Figure 2.1-1).

The project process facilities are ~~cited~~ ~~sited~~ on Quaternary alluvial sediments to the east of the bedrock outcrop line. The Pleistocene Harkers Formation alluvium is the dominant type; however, recent alluvium occupies stream channels. These alluvial types are not differentiated on the geologic map, Figure 2.1-1. Tertiary volcanic rocks, comprised chiefly of latitic flows, breccias, and agglomerates crop out to the north and south of the process facilities. The Quaternary alluvium in the process area unconformably overlies the buried volcanic rocks.

2.1.2 Geology of Mineral Deposits

The Barneys and Melco ore bodies ~~will be~~ ~~have been~~ developed as separate open pits. The Barneys ore body is hosted by the lower Permian Park City and Kirkman-Diamond Creek formations. The host rocks consist of silty dolomite with chert interbeds and calcareous sandstone, respectively, in the two stratigraphic units. The gold-mineralized zone in the Barneys deposit has been extensively oxidized and only minor sulfide minerals are present. Decalcification of dolomite and minor clay alteration of sandstones are the typical alteration products at the deposit. Overburden at the Barneys pit consists of dolomite with chert interbeds and sandstone. Strata dip gently to the north and the maximum ore depth is approximately 600 feet in the northern part of the ore body. Structurally, the deposit has been faulted by both a low-angle thrust fault and a number of high-angle normal faults. The geology of the Barneys deposit is depicted in cross

section on Figure A-I-1 which can be found in Appendix A-I. The contents of Appendix A-I is confidential and is therefore bound separately from the main body of this document.

The Melco ore body, located approximately 1.5 miles southwest of the Barneys deposit, is hosted at a structurally prepared boundary between footwall orthoquartzites of the Freeman Peak Formation and hanging wall calcareous sandstone of the Kirkman-Diamond Creek Formation. Like the Barneys Canyon deposit, the Melco ore body has been extensively oxidized. However, sulfide ore, characterized by the presence of pyrite and marcasite, occurs in the deeper parts of the ore body. Overburden at Melco consists of sandstone and quartzite. The strata hosting the ore body are vertically or near vertically dipping. The geology of the Melco deposit is shown in cross section on Figure A I-2, which can be found in Appendix A-I.

A geologic cross section (A-A') showing the pit geology and the pit outline of the proposed Melco expansion is shown on Figure 2.1-9.

The BC South deposits are hosted in Kirkman-Diamond Creek Sandstone at a structural contact with orthoquartzites of the underlying Freeman Peak Formation (Figure 2.1-10 and 2.1-11). The two deposits are approximately 1,000 feet apart. The relative locations of the deposits are shown on the Geologic Map (Figure 2.1-1). Gold mineralization is hosted in moderately dipping, clay-rich zones of slip and brachiation within interlayered sandstone and orthoquartzite. The rock sequence is very similar to that encountered at the Melco deposit; however, unlike Melco, both ore bodies are almost totally oxidized with only minor (less than 1%) sulfide-bearing rock remaining. Overburden at both deposits consists of sandstone and orthoquartzite which has been locally clay-altered. The overburden in the South BC South deposit is generally much more clay-rich than that in the North BC South deposit, owing to the more extensive brachiation and clay alteration in South BC South. Geologic cross sections of the North BC South and the South BC South deposits, showing the ultimate pit outlines, are found on geologic cross sections C-C' (Figure 2.1-10) and B-B' (Figure 2.1-11), respectively. Figure 2.1-12 is a revised geologic cross section showing the pit geology and outline of the Melco mining phases. The line of cross section is shown on the geologic map (Figure 2.1-13).

The East Barneys Canyon deposit is hosted in the Kirkman-Diamond Creek sandstone. Gold mineralization is hosted in moderately dipping, clay-rich zones of slip and brachiation within interlayered sandstone and orthoquartzite. The rock sequence is very similar to that of the BC South deposit, however, the orebody is totally oxidized. The deposit is overlain by about sixty feet of Quarternary Alluvium composed of sandstone, quartzite and limestones. A Geologic cross section of the East Barneys deposit showing the final pit outline, is denoted section A-A' on Plate 96-6 and included as Figure 3.2-12.

2.1.3 Subsurface Geology of the Process Facilities Site

The process facilities site is outlined on the geologic map (Figure 2.1-1). Drilling has been done in the process site area both for the purpose of condemnation (determination that economic mineral deposits are not present) and foundation testing. The locations of these drill holes and borings are shown on Plate II-A and geologic logs are presented in Appendix A-II. Condemnation drilling by Kennecott in the process plant area

has consisted of three rotary-reverse circulation drill holes. Geologic logs of two holes, BC-148 and BC-150 are available. Foundation investigation studies by Sergeant, Hauskins, and Beckwith (SHB) led to the drilling of a number of test borings and test pits. The locations of the deeper auger borings are also shown on Plate II-A. Additional geologic data comes from logs of water supply wells in the area. The locations of water supply wells used in evaluating the site geology are shown on Plate II-A, the Pre-Disturbance Site Map. Sources of groundwater information for the area are discussed in Section 2.3.

No faults or other geologic structures have been identified by the limited amount of drilling that has been done in the process site area. Mapped geologic structures in the Permian-aged bedrock to the west of the site (Figure 2.1-1) are not known to have been active since the mid-Tertiary or before.

A number of geologic cross sections through the proposed process facility area have been prepared using available geologic logs. The lines of section are shown on Plates I-A and II-A. The sections are shown on Figures 2.1-2 through 2.1-7. The scales, both vertical and horizontal, of the sections are variable depending on the length of the section and topographic relief along the line of section. Hence in making direct comparisons between sections, the effects of scale changes must be taken into account. The explanation for the symbols used in the cross sections is shown on Figure 2.1-8.

Cross sections A-A' (Figure 2.1-2) and A-A'' (Figure 2.1-3) are northwest trending sections drawn through the process site condemnation holes and then more than a mile southeast of the site through wells K-405 and W-32, respectively. The lines of section for each of these cross sections are shown on Plate I-A. Well K-405 is a Kennecott water production well drilled adjacent to the new Copperton Concentrator. Well W-32 is one of the two Copperton community water supply wells. These sections show that the alluvial deposits near the project site were deposited on a pediment of underlying volcanic rocks and that the dominant bedrock in the area is Tertiary volcanic flows. These sections also depict the aquifer types in the project area. In drill holes BC-148 and BC-150, the occurrence of clays identified in the rotary drill cuttings are interpreted to represent air-fall tuff beds. In each drill hole, the groundwater surface is closely associated with a tuff-derived clay layer. As discussed in Section 2.3, hydrogeologic data suggest that tuff beds in the volcanic flow sequence serve, at least locally, as confining beds or aquitards.

The geologic log of well W-32 describes volcanic rocks, presumably Tertiary in age, overlying clay-dominant sediments described as lake bed sediments and presumably of Pleistocene age. The most reasonable explanation of this incongruity seems to be that the volcanics were deposited on top of the apparent lake bed sediments by a debris flow or other mass movement. The description in the log of "rocks in mud" within occurrence interval of the volcanic rocks supports this contention.

Cross section A-A''' (Figure 2.1-4) is a northwest-trending section that extends across the entire process area. Again, the relationship of the ground water surface to the volcanic tuff layers in the volcanic flows is apparent. Because the condemnation holes were drilled by a rotary drill, detailed logs of the unconsolidated alluvium were not prepared. The logs of the auger holes are, as a result of the drilling method, more detailed. Attempts to correlate alluvial lithologies between foundation borings were made,

as the section shows; however, the drill hole density and variability in lithologies makes such interpretation difficult. It is significant that of the seven borings depicted on Section A-A'" (Figure 2.1-4), five have clay as their uppermost lithology. Each of these five borings are located on hilltops or hillsides. This relationship is displayed in most borings similarly located in the process site area.

Cross section B-B' (Figure 2.1-5) is a northeast-trending section through the western-most proposed leach pad site.

Cross sections C-C' (Figure 2.1-6) and C'-C" (Figure 2.1-7) are, respectively, northwest and northeast-trending sections in the area of the eastern-most leach pad sites. Again, as was the case in section A-A'" (Figure 2.1-4), lithologic correlation between drill holes is difficult. The geologic occurrence of very minor perched groundwater is depicted in these cross sections. This perched groundwater is discussed further in Section 2.3.

2.1.4 Seismicity

The site is located near the eastern boundary of the seismically active Basin and Range Province. Regional seismicity maps have been compiled for Utah based on historic data from 1850 to 1980 (SHB, 1988). Small to moderate sized earthquakes are numerous in the State and are largely associated with the Wasatch fault zone and Basin and Range faults such as those on the west side of the Oquirrh Range. The closest recorded earthquake was a 1962 magnitude 5.2 event in Magna approximately 9 miles north of the site.

Two mapped fault systems with Holocene activity are near the site. They are the Wasatch Fault about 16 miles to the east, and the frontal fault of the Oquirrh Range about 5 miles west of the site. The seismicity in the Magna area suggests the possibility of active faulting; however, interpretation of low-sun angle aerial photographs and aerial infrared photography indicate that there is no surface rupture in the Magna area (SHB, 1988). This has been interpreted as evidence that there have been no events larger than magnitude 6.0 near the site area during the late Quaternary.

The site does lie within the UBC-3 seismic zone and maximum credible earthquakes for various faults in the area have been calculated. The estimated horizontal bedrock acceleration resulting from a maximum credible earthquake of Magnitude 7.6 for the Wasatch Fault was used for the project site. An effective peak horizontal ground acceleration of 0.18g (corresponding to a 500 year recurrence interval) was used for the earthquake design evaluation. The earthquake design evaluation indicated that permanent deformations under this design acceleration value would be less than six inches, which is considered well within safe limits. It was also determined that major earthquakes generating accelerations of 0.2g to 0.3g would probably create slides of sufficient mass to damage the pad liner. The recurrence interval of these events is estimated at 600 to 1200 years; thus, a small risk of earthquake-induced liner damage is inherent with the use of heap placement by dumping (SHB, 1988)

2.2 Surface Water Hydrology

The mean annual precipitation in the Barneys Canyon project area is 16 inches (Dames and Moore, 1988). Approximately one third of the precipitation falls as snow from December through March and the remainder falls as rain, predominately in the Spring. Summer precipitation is largely characterized by thunderstorms influenced by the orographic effects of the Oquirrh Mountains (SCS, 1974). Annual snowfall along the Oquirrh Mountain foothills is approximately 81 inches (Dames and Moore, 1988).

Surface water drainage around the Barneys Canyon project site is governed by the north-south trending Oquirrh Mountains. These mountains rise to an elevation of 9,000+ feet AMSL (above mean sea level) or approximately 5,000 feet above the 4,300 feet AMSL Salt Lake Valley.

The Barneys Canyon Project site lies along the southeastern flank of the Oquirrh Mountains. Barneys Creek, which flows from Barneys Canyon, is intermittent at its headwaters within the project area and perennial over less than a two mile reach adjacent to the project area. Direction of flow is from west to east and is part of the Jordan River drainage, where runoff contributes to the Jordan River located roughly five miles away. Continuous stream gauging has never been performed on Barneys Creek. Other small, intermittent and ephemeral drainages in the project area are localized by the topography of the Barneys Canyon project site which consists of low hills sloping easterly at a gradient of about 10%. Elevations ~~are~~ range from 5700 feet to 7000 feet along these foothills. Many small valleys with watershed areas less than one square mile run through the site. Because of their small drainage areas, runoff from these ephemeral channels is small.

The Melco pit site is located on the drainage divide (el. 7600 top) south of Barneys Canyon and at the head of a small tributary to Dry Fork. Dry Fork is ephemeral and the runoff from the watershed formerly drained into Bingham Creek approximately two miles south (Figure 1.1-1). A waste rock dump of Kennecott's Bingham Canyon mine now fully impounds Dry Fork below the Melco pit and dumps. The Melco waste dump will lie on the southeastern edge of this ridge approximately 2500 feet southeast of the pit area. Water from this area drains into the Dry Fork basin.

Surface water quality has been analyzed from several of the springs in the area. Barneys Spring (S-318) (Figure 2.3-1)) is located approximately 1.2 miles southeast of the project area. Water quality analyses indicate high levels of total dissolved solids (TDS) (1,890 - 2,200 mg/l), chlorides (304 - 502 mg/l), and sulfates (187 - 263 mg/l). Water pH ranged from 7.3 to 8.3. Barneys Spring is believed to originate from the Tertiary volcanics. Crystal

Spring (S-316) and Maple Spring (S-319), located 2 and 4.5 miles respectively, northwest of the project site, were also analyzed for water quality. The data indicate both springs emit good quality water within the standards set by the Utah Department of Environmental Quality. These springs appear to emanate from the Pennsylvanian-age, White Pine Formation. Bancroft Spring emanates in the small valley south of the proposed leach pad area (Plate II-A) and provides a source of flow in that drainage for part of the year. Bancroft Spring appears to result from infiltrating subsurface flow in alluvial fill being intercepted by a buried occurrence of quartz latite which occurs at the location of the spring. Flow rates from this spring have been estimated at 30 gallons per minute, though

the consistency of this flow rate is unknown. Aquifer recharge from this spring is probably low due to the low permeability of the volcanic aquifer. This spring has been sampled for water quality parameters and falls within Utah Department of Environmental Quality standards. The Barneys Canyon tunnel water source, located approximately two miles southeast immediately east of the project area (Plate II-A), is of drinking water quality and has been used as culinary water at the Geology Building, Precipitation Plant, Lead Mine townsite and the uranium extraction plant. Currently this water is directed to Kennecott's Copperton concentrating facility and is being used as make-up process water. A summary of this water quality analysis may be found in Appendix B (Dames and Moore, 1988).

Several surface water sites have in the past been analyzed for water quality downgradient of the Melco mine site. Historic concentration levels from surface water sample sites S-29, S-59, S-59a, K-61, K-78, K-79, and K-102 indicate a wide range: TDS (1,300 - 46,500 mg/l), sulfate (8,600 - 17,800 mg/l), copper (6 - 11.2 mg/l), chloride (1,300 - 2,030 mg/l) and very low pH values near 3.0. A complete listing of these values may be found in Appendix B (Dames and Moore, 1988). Water quality data for Dry Fork Creek East (S-59) indicate low to moderate levels of TDS, sulfate and chloride but there are unexplained fluctuations in the values listed (Appendix B). At the Dry Fork shops site (S-29), located further downgradient, good water quality generally exists with TDS from 281 - 1,110 mg/l. Sulfate and chloride levels were also low (Appendix B) (Dames and Moore, 1988).

Modifications to natural surface water flow patterns, which have resulted from mining activities to date have been largely as predicted. A description of these modifications has been incorporated into the discussion of operational runoff controls presented in Section 3.10 of this amendment.

The Melco north dumps are located in Barneys Canyon and will affect approximately 7000 feet of the intermittent and perennial portion of Barneys Creek. The waste dumps are being will be constructed in accordance with the Utah Division of Water Quality groundwater discharge permit.

2.3 Groundwater Hydrology

2.3.1 Regional Aquifer Characteristics

The Barneys Canyon, East Barneys and South Barneys Pits and heap leaching facilities are located north and south of the mouth of Barneys Canyon along the eastern flank of the Oquirrh Mountains, Salt Lake County, Utah. Groundwater generally flows in an easterly direction from the Oquirrh Mountains toward the Jordan River. Depth to the water table in this part of the Salt Lake Valley generally increases with the rise in topographic elevation. Therefore, groundwater depths will be greatest near the mountains and shallower as distance from the mountains increases. This occurrence is characteristic of a groundwater recharge area (Waddell, Seiler and Solomon, 1987).

The aquifer materials along the margins of the Salt Lake Valley are characterized by thick unconsolidated alluvial sand and gravel deposits containing lenses and beds of finer grained sands, silts and clays. The aquifers along the valley margins are generally

unconfined and are recharged from precipitation, seepage from ephemeral streams, irrigation ditches, ponds and reservoirs, and seepage from bedrock. Recharge from the bedrock is believed to contribute the greatest volume of water (approximately 45% of total recharge) to the valley-fill aquifer. The bedrock is predominantly recharged in the upper elevations of the Oquirrh Mountains (Waddell et al, 1987).

Pump tests have been performed on the coarse grained unconsolidated aquifer beneath the valley bench near Bingham Canyon. The hydraulic conductivity of the aquifer material has been estimated to range from 1.0×10^{-4} to 3.5×10^{-4} feet per second. Hydraulic gradients are estimated at 0.063 and substratum porosity is approximately 30 percent. Using these figures as a basis for the Barneys Canyon area, average linear groundwater velocities could range from 660 to 2300 feet per year (Waddell, Seiler and Solomon, 1987).

Groundwater quality has also been characterized at several locations downgradient and north of Barneys Canyon. Water analyses show a total dissolved solids concentration ranging from 430 to 910 milligrams per liter. These dissolved constituents are dominated by calcium, magnesium, bicarbonate, and chloride.

The Melco Pit and waste dump is located near the topographic divide between Barneys Canyon on the north and Dry Fork on the south. Direction of groundwater flow from this ridge is expected to be generally subparallel to the ground surface. As an upland recharge area, groundwater depths are great (approximately 600 feet) and hydraulic gradients would be expected to be higher than gradients on the bench. The bedrock aquifer is comprised of fractured sandstone and limestone.

2.3.2 Local Recharge Characteristics

The rate of groundwater recharge is dependent on the hydraulic characteristics of the surficial soil, underlying unconsolidated sediments, and bedrock. Descriptions of the surficial soils by the Soil Conservation Service (SCS) indicate clay and silt loams are present in the Barneys Canyon project area. Infiltration rate is moderate (0.5 - 2.0 inches per hour) and permeability is slow to moderately slow (SCS, 1974). Runoff from precipitation events is rapid as these fine-grained soil layers limit the infiltration and percolation of water downward into the soil horizon. Laboratory permeability tests were also conducted on samples of compacted surficial soils obtained from the leach pad areas; Table 2.3-1 lists the results of these tests. The soils from the surface to a depth of 3 feet were classified as silty to gravelly clay with compacted permeabilities ranging from 1.1×10^{-5} to less than 1×10^{-7} cm/sec.

Table 2.3-1 Permeability of Leach Pad Area Surficial Soils

<u>Sample Site</u>	<u>Sample Depth</u>	<u>Material</u>	<u>Permeability(cm/sec)</u>
TP-1	0.5-1.5	Silty Clay	$< 1 \times 10^{-7}$
TP-5	0.5-2.0	Clay with fine sand	1.1×10^{-6}

TP-6	0.5-2.0	Sandy clay with gravel	$< 1 \times 10^{-7}$
TP-11	0.5-2.0	Sandy clay with gravel	$< 1 \times 10^{-7}$
TP-12	1.0-3.0	Gravelly clay with sand	1.1×10^{-5}

Beneath the surficial soils, the unconsolidated alluvium consists of highly variable, layers of clay, silt, sand, gravel, cobbles, and boulders. Most of the material encountered is poorly sorted including clay, silt, sand and gravel. As discussed in Section 2.1, clay or clay-rich sediments appear to be the dominant material types in the alluvium on site. The stratification of the layers is highly variable and wide changes in strata thickness occur laterally, as indicated by the geologic cross sections illustrated in Figures 2.1-2 through 2.1-8. The permeability of these materials was tested in-situ through the use of packer tests in intervals up to depths of 65 feet. Table 2.3-2 shows the results of this testwork. The measured permeabilities range from 3.9×10^{-4} to 6.9×10^{-6} cm/sec.

The lower permeability strata in the alluvium would tend to impede vertical flow of recharge water and form perched water tables. The auger drilling conducted in the alluvium did encounter isolated saturated conditions in four borings where the water was perched above the deeper bedrock aquifer within gravelly clay or sandy gravel between clay layers. The locations and depth of the water table are as follows: B-2 water depth 26.5 feet, B-2B water depth 22.7 feet, B-3 water depth 26.9 feet, and B-24 water depth 46.7 feet. Geologic cross sections in Figures 2.1-6 and 2.1-7 show the relationship of the perched water to the alluvial lithologies. The occurrence of these perched saturated conditions is not considered to be significant as the lateral extent of these conditions is limited.

Table 2.3-2 Permeability of Leach Pad Area Alluvium

<u>Boring</u>	<u>Interval (feet)</u>	<u>Material</u>	<u>Permeability(cm/sec)</u>
B-1-MW	36.3-40.6	Gravelly clayey sand	1.5×10^{-5}
B-2B-MW	36.0-40.0	Sandy clayey gravel	3.9×10^{-4}
B-5-MW	61.5-65.3	Sandy gravel with clay	1.3×10^{-4}
B-8-MW	26.1-30.2	Sandy clay and gravel	3.2×10^{-5}
B-10-MW	21.0-25.0	Sandy gravel with clay	8.5×10^{-5}
B-13-MW	40.8-45.2	Clayey sandy gravel	6.9×10^{-6}
B-14-MW	41.4-45.5	Gravel with sand and clay	3.4×10^{-4}
B-16-MW	26.1-30.3	Clayey gravel with sand	1.3×10^{-4}
B-20-MW	26.0-30.0	Clayey sand with gravel	1.9×10^{-4}
B-22-MW	26.0-29.9	Clayey sand with gravel	2.2×10^{-4}

Aquifer recharge takes place from precipitation, seepage from ephemeral ~~and intermittent~~ streams, ~~and~~ seepage from pit lakes. ~~ponds, reservoirs, irrigation ditches and from springs. Since no ponds, reservoirs, or irrigation ditches are located within the~~

project area, precipitation events alone define the quantity of water available for recharge. Barneys Creek running from Barneys Canyon is an ephemeral intermittent stream and likely contributes measurable quantities of recharge water to the alluvial aquifer during spring snowmelt and runoff events although these events are short lived and the total amount of recharge contributed by surface seepage into the alluvium appears to be limited. Lakes have formed in both the Barneys Pit and in the East Barneys Pit. Both of these lakes have maintained a neutral pH and low sulfate and metals concentrations since they formed. Pumping in the Barneys Pit has maintained a low water level which minimizes water flow from the lake into the surrounding bedrock aquifer.

Most of the groundwater recharge takes place in the higher elevations of the Oquirrh Mountains (Waddell, Seiler and Solomon, 1987). In these areas, shallow soils and fractured bedrock allow for rapid percolation of snowmelt and rain into the aquifer below. This recharge water flows down from the mountains and enters the valley fill underground. Therefore, groundwater flowing beneath the Barneys Canyon project area is mainly recharged from higher elevations while little recharge actually takes place in the project area.

2.3.3 Local Aquifer Characteristics

A total of 11 deep monitoring wells have been installed at the Melco and Barneys Canyon pit areas, the leach facility area, and nearby at the Utah Copper Concentrator. Table 2.3-3 lists these holes and the depths to the water table. Contouring the water elevation data from these holes shows that the main water table surface subparallels the land surface at the Barneys Canyon project site (Figure 2.3-1). From the proposed mine area, flow is generally eastward toward the Jordan River. The hydraulic gradient at the leach pad site is steep, at around 0.1 ft/ft, but decreases to about 0.03ft/ft under the 5,300 topographic contour about one mile east of the leach pads. Water table depths vary from 600 feet at the Melco Pit site to between 140 to 350 feet below the ground surface in the Barneys Canyon Pit area. Water table depths in the leach pad area range from 145 to 160 feet below the ground surface (Dames and Moore, 1988).

The main aquifer is composed of volcanic rocks consisting of andesite, latite porphyry, latite tuff, and dacite. Aquifer tests from wells near the Utah Copper Concentrator located about 1.5 miles from the project site reveal aquifer permeabilities in the volcanic rocks range from 0.098 - 3.0 feet/day. However, aquifer tests of drill holes BC-148 and BC-150, located at the Barneys leach facility, indicate hydraulic conductivities of 6×10^{-3} ft/day and 1×10^{-4} ft/day respectively which are considerably less than the down-gradient well. Therefore, given a hydraulic gradient of 10% and a porosity of 0.3, calculated rates of bedrock groundwater flow velocity under the leach pad area would range from 0.01 to 0.12 feet per year.

Certain site specific data suggest that the bedrock aquifer in the vicinity of the leach facilities is confined. The Kennecott drill hole BC-148 encountered water during drilling at a depth of 165 feet, immediately beneath a clay-rich volcanic ash bed. Subsequent measurements of the water level in this hole have revealed depths to the water from 122 to 123 feet which would indicate that the bedrock aquifer in this hole is confined. To better quantify the hydraulic characteristics of the aquifer below the Barneys Canyon facilities,

all future monitoring and water wells drilled in the area will be field tested using pump tests, packer tests or slug tests.

The other leach facility drill hole, BC-150, located about 1 mile downgradient from BC-148, also encountered a clay-rich ash zone above the water table, although the water table in this location is beneath the bottom of the clay zone. This clay zone may be equivalent to that which forms the aquitard in BC-148 and may also act as an aquitard in this location.

Table 2.3-3 Water Table Depths in Project Area

<u>Drill Hole</u>	<u>Surface El.(ft.)</u>	<u>Water Depth(ft.)</u>	<u>Water El.(ft.)</u>
BC-65	6623.1	356.7	6266.4
BC-68	6564.4	292.	6272.4
BC-69	6280.	136.6	6143.4
BC-71	6374.8	157.6	6217.2
MC-31	7422.	595.9	6826.1
BC-148	6170.1	123.2	6046.9
BC-150		125.	
BC-153		160.	
W-31	5368.	140.	5228.
W-32	5313.	87.	5226.
K-404	5620.	124.4	5495.6
K-405	5560.	296.	5264.0

Maple and Crystal Springs, draining groundwater from the Pennsylvanian-age, White Pine Formation, are upgradient of the Barneys Canyon project site. Bancroft Spring is located approximately 900 feet south of the leach pad area. Investigations on the water quality and yield of this spring are in progress and information will be provided when available.

The Melco Pit site is located along a topographic divide along the southern border of Barneys Canyon. The upper portion of the mine pit area rests about 1,000 feet higher than the Barneys Canyon Pit site. The potentiometric surface beneath the ridge lies at a depth of approximately 600 feet below the topographic surface. The aquifer is made up of Kirkman, Clinker and Curry Formations which typically have quite low permeabilities. Since no aquifer tests have been done at this site, permeabilities are estimated to be the same as the aquifer beneath Barneys project site. Assuming a hydraulic gradient of 10% and a porosity of 30%, groundwater flow velocities would not significantly differ from those calculated at the Barneys Canyon project area.(Dames and Moore, 1988)

Extensive additional exploration drilling in and around the Melco pit area indicates that the water level measured in hold MC-31 was a localized anomaly and that the water

table is below the 6400 feet AMSL.

2.3.4 Baseline Groundwater Quality

Recent characterization of the groundwater quality from wells and springs near the Barneys Canyon Project area has been performed. Since few activities have occurred north of Bingham Canyon along the base of the Oquirrh Mountains, groundwater quality has likely remained unaffected by man's activities.

Water quality analyses performed on the wells at the new Utah Copper Concentrator (W-31 and W-32-A), three monitoring wells located 1 to 3 miles downgradient of the project site (P-275, P-276, and P-278B) and Barneys Spring (S-318), indicate that groundwater quality downgradient is generally good with the exception of high concentrations of chlorides (200 - 500 mg/l) and high total dissolved solids (TDS)(1039 - 1650 mg/l) (Appendix B). Values greater than 500 mg/l exceed secondary drinking water standards. Water quality analyses from samples taken from monitoring wells BC - 148 and BC - 150 west and south of the leach pad area indicate groundwater quality is good. TDS values range from 825 to 904 mg/l. Field electrical conductivity measurements in these wells were 1100 and 1610 umhos (see Appendix B). Water quality analyses were conducted on samples for Bancroft Spring, located south of the proposed leach pads. Water quality in this spring reflects many of the same general chemical concentrations as was found in the other springs and wells. The results of this analysis may be found in Appendix B.

Baseline groundwater quality parameters have not been examined at the Melco Pit site. The nearest locations from which water quality data has been investigated is 2.3 miles downgradient of the pit in the Dry Fork Creek drainage basin (Figure 2.3-1), southeast of the Melco Pit site. In 1976, concentration levels of TDS (1,300 - 46,500 mg/l), sulfate (8,600 - 17,800 mg/l), copper (6 - 11.2 mg/l), chloride (1,300 - 2,030 mg/l) and very low pH values near 3.0 were encountered (Dames and Moore, 1988). A complete listing of these values may be found in Appendix B.

None of the wells or springs sampled during the baseline investigations occur in the vicinity of either the Melco pit or the ~~site of the planned BC South pits~~. Kennecott monitors wells located near the existing heap leach facilities. These results are regularly reported to the Division of Water Quality. No significant changes in water quality have been documented; however, because a much greater number of samples have been taken, a more statistically significant background data base has been established. These data are available either from the files of Kennecott or the Division of Water Quality.

2.3.5 Melco and BC South Deposit Area Aquifer Characteristics

The enlarged Melco pit and the BC South pits are not predicted to encounter the local water table, based upon comparison of the planned pit-bottom elevations with the ground water elevation contour map and data gathered from exploration drill holes.

The bottom of the expanded Melco pit will be at approximately 6460 6480 feet AMSL. Extensive additional exploration drilling in the area indicates that the water level measured in hole MC-31 was a localized anomaly and that the water table is below 6400 feet AMSL. To date, no significant quantities of water have been intercepted in the planned pit area.

The water table in the vicinity of the BC South deposits is estimated to occur within an elevation range of 6200 to 6400 feet AMSL, according to information provided in the 1989 NOI. The final pit depths for the North BC South and South BC South pits are estimated to be about 6475 feet AMSL and 6575 feet AMSL, respectively. No water was encountered in exploratory drill holes within the proposed limits of the North BC South pit. Minor amounts of water were encountered during drilling within the proposed South BC South pit area. These occurrences were found at relatively shallow depths in five closely spaced drill holes near the south edge of the deposit (Figure 2.3-2). As Figure 2.3-2 shows, the three northeastern drill holes found water at depths ranging from 15 to 55 feet while the two holes located further to the west encountered water at depths of 145 to 225 feet. The water flow rates shown on Figure 2.3-2 represent flows at the wellhead estimated by Kennecott geologists during drilling by air rotary methods. None of the holes flowed due to artesian conditions. The deepest of these occurrences was encountered at an elevation of 6800 feet AMSL, approximately 500 feet above the predicted water table elevation. These water occurrences probably represent two perched horizons of limited extent as depicted in the cross section shown on Figure 2.3-3. These water occurrences are found in the clay-altered quartzite which comprises the ore and waste in the southwest corner of the deposit where the perched zones are clustered. The strata in the BC South pit area dip moderately to the northeast (Figure 2.1-2), suggesting that the perched horizons are probably not controlled by bedding planes. No other information on the geologic setting of these occurrences is known. The proposed open pit does not reach the identified perched water occurrences in the immediate vicinity of the five exploration drill holes (Figure 2.3-3). The open pit will ~~did~~ reach the elevation of these perched occurrences several hundred feet to the north of the boreholes, but it did not encounter any significant perched zones. ~~no exploration holes in this part of the proposed pit encountered water (Figure 2.3-2). It is unlikely that the pit will encounter the perched ground-water zones found by the five exploration holes drilled near the south margin of the site of the BC South pit. The water encountered is very localized, perhaps trapped by clay zones in the altered bedrock. Both of the South Barneys Canyon pits remained dry during mining operations.~~

2.3.6 East Barneys Aquifer Characteristics

Drilling at the East Barneys deposit has encountered water at two levels: perched along the alluvium-bedrock contact and at a sub-surface the bedrock water table about 60 feet below the designed pit bottom. ~~No subsurface aquifers are expected to be encountered below the bedrock contact in the pit area. A shallow perched lake has formed in the East Barneys Pit since closure.~~

2.4 Soils

2.4.1 Technical Approach

A soil survey was conducted by JBR Consultants Group in October-November, 1987 at the Barneys Canyon project site. This survey was supplemented and expanded in October, 1991. The SCS Soil Survey of Salt Lake Area, Utah was used as the basis for the ground survey. Pits or fresh road cuts were used to obtain profile descriptions and define the actual soil boundaries on the project site. Soil samples were obtained and sent to a commercial laboratory for fertility analyses. The average surface layer and subsurface layer thicknesses were used to define potential maximum topsoil depths.

In September 1993, an additional supplemental field soil investigation was conducted by JBR Consultants Group to include soils in the proposed mining expansion area in Barneys Canyon. This investigation consisted of verification and/or refinement, as necessary, of the 1987/91 soils maps and collection of topsoil samples for lab analysis in the area of proposed new developments in Barneys Canyon.

As a result of this supplemental investigation, some minor modifications have been made to the original soils map, resulting in the new Melco Area Soils Map (Plate III-C). The types and quantities of topsoil in the 1993 survey (the Melco expansion area) are detailed in table 2.4-1.

Nutrient and sodium absorption ratio (SAR) analyses were conducted on topsoil samples to determine if any amendments to the topsoil would be needed during reclamation. Topsoil depths were also measured and were determined to be approximately the same as those listed in the previous 1987 - 91 studies.

2.4.2 Soil Types

The soils on the east slope of the Oquirrh Range are derived from mixed sedimentary rocks or the alluvium and colluvium from mixed sedimentary rocks. The soils of the 1993 extended project area all lie above 6,300 feet AMSL and, thus, were not influenced by the prehistoric Lake Bonneville. The soils are calcareous throughout with additional, but variable, lime accumulation in the C horizons. The B horizons are well developed in the deeper soils.

Plate IV-A presents the soil map for the initial project area. Five soil associations occur within the project area. The Agassiz-Bradshaw Association is found on steep slopes in the Melco pit area. The Fitzgerald soils are found on the north-facing slopes with fir forests. The Gappmayer-Wallsburg Association is found on ridges along the Melco haul road. The Harker soils are found in the Barneys Canyon pit and dump areas. The Dry

Creek-Copperton Association is found on the lower slopes where the leach pads will be sited.

Plate III-B presents the baseline soil map for the BC South and the expanded Melco project areas. Two soil associations (Bradshaw-Agassiz Association and Gappmayer-Wallsburg Association) occur within these project areas.

Plate III-C is the modified soil map for the study area. Two main soil association were surveyed in the Barneys Canyon extended study area. Both the Bradshaw-Agassiz and the Gappmayer-Wallsburg associations are found on the steep south-facing slopes of Barneys canyon. In addition, five main soil series have been identified in the Barneys Canyon study area. In general, within this study area, soil types are closely associated with vegetation types. Agassiz soils are found on the convex portions of the long, steep, south-facing slopes in the study area. Bradshaw soils occur in association with Agassiz soils occupying the concave portions of steep, south-facing slopes. Daybell soils are located on east and north-facing slopes and are usually defined by the aspen groves they support. Fitzgerald soils are found on the steep north-facing slopes in association with conifer and aspen forests. Gappmayer soils are found on less steep north-facing slopes at lower elevations.

In addition to the five main soil types identified in Barneys Canyon, there are three soil types of minor occurrence. The Wallsburg soils occur with the Gappmayer soils usually occupying ridge tops and the upper parts of steep slopes. Rock outcrops are found throughout the study area on mountain crests and ridges. Deep alluvial soils occur in the drainage bottoms.

The full profile descriptions for the soil associations can be found in Appendix C-II. Detailed descriptions of each soil association are presented below.

The soil chemistry descriptions can be found in Appendix C-III. Detailed descriptions of each soil association are presented below.

Laboratory reports for soil fertility and chemistry are presented in Appendix C-III. In general, the results of the laboratory analyses indicate that the soils available for salvage are of good quality having good nutrient values. Organic matter content is generally high. The soils are generally neutral and have high cation exchange ratios. Phosphorus contents are normal, ranging from 804 to 872 mg/kg. Despite the high chemical quality of the topsoil, much of the topsoil is not suitable for salvaging because of the high quantity of rock fragments, steep slopes, or shallow solum profiles.

Bradshaw-Agassiz Association

Bradshaw

Bradshaw soils occur in association with Agassiz soils occupying the concave portions of steep, south-facing slopes. Taller oak and maple/chokecherry stands

indicate the presence of Bradshaw soils. The surface layer is very cobbly silt loam as is the lighter colored subsurface layer. The horizons are weakly developed. The substratum is colluvium developed from limestone and quartzite. According to the SCS the potential for erosion is high. While these soils have relatively poor quality topsoils, the greater depths of the solum, and thus greater volume of soil available, makes stripping desirable. Topsoil depth averages 20 inches but approaches 50 inches in the small drainages and near the bottom of slopes. Stripping would be difficult on the steep slopes but perhaps 70% of the potential topsoil could be recovered, especially if the stripping operation concentrated on the areas of deepest soils. Topsoil quality is rated poor due to excessive amounts of gravels and cobbles in the profile but the soil materials are very fertile as evidenced by increased plant growth in comparison to Agassiz soils.

Agassiz

Agassiz soils are found on the convex portions of the long, steep, south-facing slopes in the study area. The scrubby low-growth of gambel oak indicates that these soils are shallow and low in fertility. The topsoil depth is generally equal to the solum depth, averaging 10 - 12 inches. The quality is poor due to excessive gravel and cobbles in the profile. The SCS describes the potential for erosion as high. Generally it would be unprofitable to strip these soils due to the steepness of the sites and the difficulty of removing the low oak cover. If these soils are to be stripped, the crests of the convex slopes where the soil is shallowest should be avoided.

Daybell

These soils are located on east- and north-facing slopes and are usually defined by the aspen groves they support. However, some Daybell soils also support a mixed stand of conifers and aspen. The Daybell series consists of somewhat excessively drained soils. These soils developed in residuum and colluvium from mixed sedimentary rocks. Slopes range from 40 to 70 percent. The surface layer is dark grayish-brown silt loam and varies greatly from 2 - 29 inches but averages 12 inches. Subsurface layers range from brown to light yellowish-brown very cobbly light sandy loam to a depth of 60 inches or more. The topsoil quality is fair as fertility is good but the soil is excessively gravelly. The topsoil texture is good enough, however, for stripping and should be recovered where feasible. Stripping will only be feasible on the deeper profiles found on the lower portions of the slopes. The removal of aspen and conifer trees will account for about 6 - 9 inches of soil loss, reducing the available topsoil by 30 - 50 percent, depending on the depth of the profile.

Fitzgerald

These soils are found on north-facing slopes where conifer stands are prevalent. The surface layers are dark grayish-brown gravelly loam and the subsurface layers

are yellowish-brown gravelly silt loam. The substratum is colluvium and residuum from mixed sedimentary rocks. The SCS lists the potential for erosion as high for this soil type. The average topsoil depth is 18 inches but varies from 10 - 30 inches; the marker of the bottom of the topsoil is the presence of rocks and a yellow-brown sub-soil. The topsoil quality is fair; the presence of excessive gravels lowers the overall quality rating. While soils will be lost when the trees are removed, efforts should be made to recover the remaining soil, especially in the areas of deeper soils.

Gappmayer-Wallsburg Association

Gappmayer

Gappmayer soils are found on the less steep slopes at the lower elevations of the study area. The parent material is colluvium and residuum from mixed sedimentary rocks. The surface layer is very cobbly loam and gravelly silt loam and the subsurface layers are very gravelly silt loam. The SCS states that the potential for erosion is moderate. The mean thickness of this soil unit is 20 inches. It usually supports shrubs and grass but it does extend into the lower elevation conifer stands in some areas. It also forms an ecotone with the Fitzgerald soils. The topsoil quality rating is poor due to the presence of excessive gravels or cobbles. However, the silt loam texture provides a good base for soil fertility. Because this occurs on less rigorous sites it will be easier to strip and recover most of the available topsoil from this unit.

Wallsburg

Wallsburg soils are of minor occurrence in Barneys Canyon. They occur with the Gappmayer soils usually occupying the ridge tops and upper parts of steep slopes. The parent material is colluvium and residuum from mixed sedimentary rocks. The surface layers are very cobbly loam while the subsurface layers are very cobbly silty loam. Bedrock is present at 17 inches. The depth of topsoil is about 15 inches. The potential for erosion is described as high by the SCS. Wallsburg soils are rated unsuitable for topsoil due to the presence of excessive cobblestones throughout the profile. Topsoil from this series should not be considered for stripping.

Rock Outcrops

Rock Outcrops are on ridge-tops and on steep slopes. The crests of the ridges are generally marked by the growth of mountain mahogany shrubs that manage to grow in the rock fractures. These sites have no appreciable soil and should not be considered suitable for stripping.

Alluvial Soil

These soils occur in the drainage bottoms in Barneys Canyon. They are generally deep and very fertile throughout their profile. The range of depths observed during the survey was from 12 to 72 inches. An average depth could not be determined given the small number of observation points and the wide, erratic range of depths observed. Topsoil quality is excellent and these soils should be recovered completely and stockpiled for future reclamation efforts. These soils can be mixed with lesser quality topsoil materials to increase the fertility and volume of the topsoil materials suitable for reclamation.

Table 2.4-1 Summary of Topsoil Materials in the Melco Study Area

Soil	Terrain	Quality	Texture	Mean Depth (inches)	Area (Acres)	Marker*	Salvageable Volume** (CY)
Outcrops	Ridge crests	Unsuitable	Rocky	0	61	None	0
Alluvial	Drainages	Excellent	Silt and clay loams	42	63	Gravel beds	249,018
Agassiz	Steep convex slopes, south aspect	Poor	Gravelly loam	10	120	Bedrock	112,929
Bradshaw	Steep concave slopes, south aspect	Poor	Gravelly/cobbly silt loam	20	153	Excess gravel	287,986
Daybell	Steep slopes, north aspect	Fair	Gravelly silt loam	12	75	Sandy loam	84,700
Fitzgerald	Steep slopes, north aspect	Fair	Gravelly loam	18	131	Excess stones	221,914
Gappmayer	Moderate slopes, north aspect	Poor	Very gravelly silt loam	20	71	Yellow-brown layer	133,640
Mixed Fitzgerald/Gappmayer	Moderate to steep slopes, north	Fair to poor	Gravelly loam to very gravelly	19	40	Excess stones or yellow-brown	71,523

	aspect		silt loam			layer	
Wallsburg	Mountain slopes	Unsuitable	Cobbly silt loam	0	15	None	0
Totals					729		1,161,710

* Marker is the diagnostic field feature for lower limits of topsoil materials

** Volume is based on efficiency of stripping operation which may loose 30% or more on steep slopes or under large plant cover.

2.4.3 Topsoil Fertility

All the soil materials are very gravelly and/or cobbly so they have large amounts of coarse materials. The soil textures range from loams to silt or clay loams. The organic matter is usually above seven percent which is higher than that normally found in Basin and Range soils. Sufficient plant macronutrients of nitrates, calcium, potassium and magnesium are present for plant growth.

The lab analyses indicate very high iron levels in a few locations. The blending of topsoil materials should ameliorate hot spots.

See Appendix C-III for detailed lab results.

Bradshaw-Agassiz Soils

These cobbly sandy loams are relatively neutral with a high percentage of organic matter in the surface and subsoil horizons. The cation exchange capacity is good. The phosphate levels are good and the other major nutrients are adequate.

Fitzgerald Soil

These cobbly sandy loams are relatively neutral with a high percentage of organic matter in the surface and subsoil horizons. The cation exchange capacity is high. Phosphate levels are good and the other major nutrients are adequate.

Daybell Soils

These sandy loam soils are relatively neutral and moderately fertile with high organic matter (above ten percent) in the surface and subsoil horizons. The cation exchange capacity is very high. Phosphate levels are good and the other major nutrients are adequate.

The other soil groups have been described in previous reports.

Gappmayer-Wallsburg Soils

These soils are neutral and moderately fertile. The organic matter is about 1.5%. The phosphates are low. Some higher-than-normal copper and sulfate levels are found in the surface horizons.

Copperton Soils

The relatively shallow Copperton soils are slightly acidic with moderate fertility. There is a moderate amount of organic matter in the topsoil materials. The copper content is relatively high in the surface layer.

Harker-Dry Creek Soils

These soils are generally deeper than other soils of the area and will provide the bulk of the topsoil material. This is especially true for the Harker soils which are the deepest soils and occupy much of the disturbed areas of the Barney Pit and dumps. The soil texture varies from loam to clay loam with clays in the lower B horizons.

The soils are neutral to slightly alkaline with moderate fertility. The percent of organic matter varies but is generally lower than the other soils in the area. Phosphates are low as expected. One incident of high copper levels in the surface horizons was found.

All the soil materials are very gravelly and/or cobbly so they have large amounts of coarse materials. The soil textures range from loams to silt or clay loams. The organic matter is usually above seven percent which is higher than that normally found in Basin and Range soils. Sufficient plant macronutrients of nitrates, calcium, potassium and magnesium are present for plant growth.

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The other soil groups have been described in previous reports.

2.4.4 Soil Descriptions

The data for the soil descriptions was taken the field surveys, the lab fertility analyses

available in Appendix C-III and from the U.S.D.A., S.C.S. Soil Survey of Salt Lake Area, Utah, April 1974.

Series: Agassiz

The Agassiz soil is found in association with Bradshaw soils on the steep south-facing convex portions of slopes.

Family: loamy-skeletal, mixed, frigid Lithic Haploxerolls

Parent Material: residuum and colluvium from mixed sedimentary rock, mainly calcareous quartzite and limestone

Landforms: steep, south-facing slopes, 40 - 70 percent, convex sites

Solum Depth: 12"; range from 6" - 16"

Erosion Hazard: water = high

Range Site: Mountain Shallow Loam

Topsoil Rating: poor

depth: 10"

texture: gravelly or cobbly loam

pH: 6.9, neutral

salinity: none

water holding capacity: 0.10 - 0.12 in/in, low

Typical Pedon:

O1 2 - 0 inches; leaf and twig litter (O1 not always present at every site).

A1 0 - 10 inches; dark grayish brown (10YR 4/2) cobbly or gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; clear wavy boundary.

C1 10 - 16 inches; brown (10YR 5/3) very cobbly silt loam, dark brown (10YR 3/3) moist; very weak, small subangular blocky structure to weak granular structure; slightly hard to loose, very friable, sticky, slightly plastic; common fine roots; abrupt irregular boundary.

R Calcareous quartzite.

Series: Bradshaw

Bradshaw soils occur in association with Agassiz soils on the steep south-facing concave portions of slopes. They are deeper than Agassiz soils and support taller oak and maple/chokecherry woodlands.

Family: loamy-skeletal, mixed, frigid Typic Haploxerolls

Parent Material: colluvium of weathered mixed sedimentary rocks, mainly calcareous quartzite and limestone

Landforms: steep, south-facing slopes, 40 - 70 percent, concave sites

Solum Depth: 50+"

Erosion Hazard: water = high

Range Site: Mountain Stony Loam

Topsoil Rating: poor

depth: 20 inches

texture: very gravelly or cobbly silt loam

pH: 6.9, neutral

salinity: none

water holding capacity: 0.07 - 0.10 in/in, low

Typical Pedon:

O1 2 - 0 inches; leaf and twig litter.

A11 0 - 9 inches; dark brown (7.5YR 4/3) gravelly or cobbly loam, dark brown (7.5YR 3/2) moist; moderate fine granular to small subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; common fine and very fine roots and few medium roots; clear, smooth boundary.

A12 9 - 19 inches; dark brown (7.5YR 4/3) gravelly or cobbly clay or silt loam, very dark brown (7.5YR 3/3) moist; moderate, fine granular or small subangular blocky structure; soft, friable, sticky, plastic; common fine and medium roots; gradual, wavy boundary.

B2 19 - 39 inches; dark brown (7.5YR 4/4) very gravelly silt loam, dark brown (7.5YR 3/4) moist; weak, medium and fine subangular blocky to granular structure; soft, friable, slightly sticky and slightly plastic; common fine and few medium roots; gradual, wavy boundary.

C1 39 - 50+ inches; dark brown (7.5YR 5/3) very gravelly silt loam, dark brown (7.5YR 4/3) moist; massive; hard, very firm, slightly sticky, slightly plastic; 80 percent coarse fragments; lime coating on large fragments.

R Weathered limestone.

Series: Daybell

Family: coarse-loamy over fragmental, mixed Pachic Cryoborolls

Parent Material: residuum and colluvium from mixed sedimentary rocks

Landforms: east and north-facing slopes, 40 - 70 percent

Solum Depth: 30"

Erosion Hazard: water = high

Range Site: High Mountain Stony Loam

Topsoil Rating: fair

depth: 12"

texture: very gravelly silt loam

pH: 6.4, neutral

salinity: none

water holding capacity: 0.09 - 0.10 in/in, low

Typical Pedon:

- A11 0 - 9 inches; dark grayish brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; soft, very friable, slightly sticky, non-plastic; common fine roots and few medium roots; 30 percent gravel; slightly acid (pH 6.4); clear, smooth boundary.
- A12 9 - 16 inches; brown (10YR 4/3) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine and few medium roots; 30 percent gravel; slightly acid (pH 6.4); clear wavy boundary.
- C1 16 - 21 inches; brown (10YR 5/3) gravelly fine sandy loam, dark brown (10YR 4/3) moist; weak, very fine, granular structure; soft, very friable, nonsticky, non-plastic; common fine roots and few medium roots; 35 percent gravel and cobbles; slightly acid (pH 6.4); clear wavy boundary.
- C2 21 - 52 inches; pale brown (10YR 6/3) very cobbly light sandy loam, yellowish brown (10YR 5/4) moist; weak, very fine, granular structure; slightly hard, very friable, nonsticky, non-plastic; few fine and medium roots; 50 percent cobbles and gravel; slightly acid (pH 6.4); gradual, irregular boundary.
- C3 52 - 60 inches; light yellowish brown (10YR 6/4) very cobbly fine sandy loam, dark yellowish brown (10YR 4/6) moist; weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky, non-plastic; 60 percent cobbles and gravel; slightly acid (pH 6.4).
- R Sandstone.

Series: Fitzgerald

Family: loamy-skeletal, mixed, frigid Mollic Paleboralfs

Parent Material: residuum and colluvium from mixed sedimentary rocks

Landforms: north-facing slopes

Solum Depth: 60+"

Erosion Hazard: water = high

Range Site: none

Topsoil Rating: fair

depth: 18"

texture: gravelly loam

pH: 7.2, neutral

salinity: none

water holding capacity: 0.06 - 0.08 in/in, low

Typical Pedon:

- O2 0 - 2 inches; very dark grayish brown (10YR 3/2) litter of partially decomposed leaves, grass, and other plant residue, very dark brown (10YR 2/2) moist.
- A11 0 - 4 inches; very dark grayish brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; soft, very friable, nonsticky, non-plastic; common fine, medium and large roots; neutral (pH 6.8); clear, smooth boundary.
- A12 4 - 8 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; soft, very friable, slightly sticky, non-plastic; common fine, medium, and large roots; neutral (pH 6.8); abrupt, wavy boundary.
- A2 8 - 18 inches; light yellowish brown (10YR 6/4) very gravelly silt loam, yellowish brown (10YR 5/4) moist; moderate, fine granular structure; soft, very friable, slightly sticky, non-plastic; common fine, medium, and large roots; neutral (pH 6.6); gradual, irregular boundary.
- B&A 18 - 34 inches; mixed B2t and A2 horizons; B2t part is brown (7.5YR 5/4) very gravelly loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky, non-plastic; few thin clay films; A2 material is like that in the A2 horizon; few fine and large roots; neutral (pH 6.6); clear, wavy boundary.
- B2t 34 - 70 inches; reddish yellow (7.5YR 6/6) very gravelly sandy clay loam, yellowish brown (10YR 5/5) moist; moderate, medium, subangular blocky structure; very hard, friable, sticky, plastic; few moderately thick clay films on peds and thin, continuous clay films on coarse fragments; few fine and large roots; neutral (pH 6.6).

Series: Gappmayer

This soil is common at elevations just below Barneys Canyon and occurs only at a few sites in the Barneys Canyon area.

Family: loamy-skeletal, mixed, frigid Boralfic Argixerolls

Parent Material: residuum and colluvium of mixed sedimentary rocks

Landforms: northerly slopes, 30 - 60 percent

Solum Depth: 60+"

Erosion Hazard: water = moderate

Range Site: Mountain Gravelly Loam

Topsoil Rating: poor

depth: 20"

texture: very gravelly silt loam

pH: 6.6 - 7.3, neutral

salinity: none

water holding capacity: 0.08 - 0.10 in/in, low

Typical Pedon:

- O1 2 - 0 inches; undecomposed to slightly decomposed litter of oak and conifer leaves and grass.
- A1 0 - 10 inches; very dark grayish-brown (10YR 3/2) very cobbly loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; soft, very friable, nonsticky, non-plastic; many fine and medium roots and few large roots; common fine pores; neutral (pH 6.6); clear, wavy boundary.
- A12 10 - 16 inches; grayish brown (10YR 5/2) very gravelly silt loam, dark grayish brown (10YR 3/2) when crushed, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and medium roots and few large roots; common fine pores; neutral (pH 6.6); abrupt, wavy boundary.
- A2 16 - 20 inches; pale brown (10YR 6/3) very gravelly silt loam, dark brown (10YR 4/3) moist; moderate, fine and medium, granular structure; slightly hard, very friable, slightly sticky, slightly plastic; common fine pores, neutral (pH 6.6); abrupt wavy boundary.

- B21t** 20 - 26 inches; pale brown (10YR 6/3) gravelly silty clay loam, grayish brown (10YR 5/2) when crushed, brown (7.5YR 4/4) moist, brown (7.5YR 4/3) moist and crushed; moderate, medium and fine subangular blocky structure; hard, friable, sticky, plastic; common fine roots and few medium and large roots; moderately thick, continuous clay films on most peds and coarse fragments; some peds coated with bleached sand; neutral (pH 6.8); clear, wavy boundary.
- B22t** 26 - 44 inches; light yellowish brown (10YR 6/4) very gravelly clay loam, dark yellowish brown (10YR 4/4) moist; moderate, medium and fine, subangular blocky structure; very hard, friable, sticky, plastic; common fine roots and few medium and large roots; thin, continuous clay films on coarse fragments; neutral (6.8); clear, wavy boundary.
- C1** 44 - 72 inches; pale brown (10YR 6/3) very gravelly silt loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; common fine roots and few medium roots; below depth of 60 inches this horizon has thin lime coatings on undersides of coarse fragments; matrix noncalcareous; neutral (pH 7.2).

Series: Wallsburg

Family: clayey-skeletal, montmorillonitic, frigid Lithic Argixerolls

Parent Material: residuum and colluvium from sedimentary rocks

Landforms: mountain slopes

Solum Depth: 17"

Erosion Hazard: water = high

Range Site: Mountain Shallow Loam

Topsoil Rating: not suitable

depth: 17"

texture: cobbly silt loam

pH: 6.5 - 7.3, neutral

salinity: none

water holding capacity: 0.05 - 0.10 in/in, low

Typical Pedon:

O1 1 - 0 inches; leaves and twigs.

A1 0 - 5 inches; grayish brown (10YR 5/2) very cobbly silt loam, very dark grayish brown (10YR 3/2) moist; weak, thin platy structure parting to moderate, fine, granular; soft, very friable, slightly sticky and slightly plastic; common fine roots; 50 percent cobblestones and gravel; neutral (pH 6.6); clear, wavy boundary.

B1t 5 - 9 inches; dark brown (10YR 4/3) very cobbly silty clay loam, very dark grayish brown (10YR 3/2) moist, dark brown (7.5YR 3/2) moist and crushed; very hard, friable,

sticky, plastic; common fine roots; 60 percent cobblestones; thin continuous clay films; neutral (pH 6.6); clear, wavy boundary.

B2t 9 - 17 inches; brown (7.5YR 5/4) very cobbly light silty clay, dark brown (7.5YR 3/3) moist, brown (7.5YR 4/3) when moist and crushed; strong, medium and fine, angular blocky structure; extremely hard, firm, sticky, plastic; common fine roots; 70 percent cobblestones; thin, continuous clay films; neutral (pH 6.6); clear, irregular boundary.

R 17+ inches; fractured rock.

2.5 Vegetation

The Barneys Canyon area of the Oquirrh Mountains ranges from an elevation of 8,242 feet at Barneys Peak to 6,250 feet at the Melco Haul Road that defines the study boundary. Several plant communities inhabit the steep canyon walls and bottom.

The steep terrain emphasizes the difference in north and south aspects. Douglas fir (Pseudotsuga menziesii), quaking aspen (Populus tremuloides), with intermingled heavy stands of gambel oak (Quercus gambelii) and curl-leaf mountain mahogany (Cercocarpus ledifolius) shrubs characterize north aspects. South aspects mostly support pure gambel oak stands, and on the rocky soils and rock outcrops, curleaf mountain mahogany stands. Steep drainages on the south-facing slopes and the canyon bottom are mostly dominated by the bigtooth maple (Acer grandidentatum)/chokecherry (Prunus virginiana) - riparian community. Sagebrush (Artemisia tridentata) also exists at all south-facing slope elevations associated mostly with the gambel oak community, but only becomes dominant on the higher slopes and ridge tops above the study area.

A vegetation community map was developed for all the area affected by the overall mining project. This map is presented on Figure 2.5-1. The area was surveyed on the ground and community boundaries drawn onto topographic maps. One hundred-foot, line-point transects were run in each major plant community on the sites of proposed mining activity.

The vegetative mapping arbitrarily established boundaries for the various oak shrub communities as described above. In reality these communities do not have definite boundaries but grade from one community to the next. Thus, many community boundaries or extremities are characterized by ecotones. Also many subcommunities or extensions of adjacent communities can exist within the major communities usually due to terrain aberrations.

2.5.1 Methodology

In September 1993 the vegetation of the Barneys Canyon expansion area was mapped and this map is presented as Plate V-C. The area was surveyed on the ground and community boundaries drawn onto topographic maps.

The mapping of communities required the use of aerial photos, U.S.G.S. 7.5 minute maps, and ground-truthing. Ground transects provided a data base of species frequency and dominance for the community descriptions.

The communities were identified by the dominant plant species, which were

determined by canopy dominance. For each representative vegetation community, transects were conducted to measure percent cover of dominant species and percent composition of all species encountered.

One hundred-foot, point-intercept transects were conducted in each of the main vegetative communities on the sites of proposed mining activity. Understory as well as canopy species were noted at each foot mark of the transect. The number of transects needed for sample adequacy was determined by using the following formula:

$$n = \frac{t^2 s^2}{(0.2 x)^2}$$

where n = the desired sample size,

t = the table "t" value at the given confidence level,

s = the standard deviation,

0.2 = the confidence interval around the mean, and

x = the mean

Sample adequacy was achieved at the 80% confidence level.

The vegetative mapping established approximate boundaries for the various communities as described above. In reality these communities do not have definite boundaries but grade from one community to the next. Thus, many community boundaries or extremities are characterized by ecotones. Also many subcommunities or extensions of adjacent communities can exist within the major communities usually due to terrain aberrations.

2.5.2 Survey Results

2.5.2.1 Gambel Oak Community

The Gambel Oak (Quercus gambelii) Community mostly occurs as small shrubs on the higher exposed south-facing ridges, as tall shrubs or small trees on the protected upper slopes, or as medium shrubs at mid-slopes and on the lower alluvial slopes. Occasionally, oak stands occur on north-facing slopes mixed in with the douglas fir (Pseudotsuga menziesii) and aspen (Populus tremuloides) communities.

Within the study area, this plant community ranges in elevation from 6,300 feet near the Melco haul road to 7,600 feet at the extreme northwest corner of the study area. It is characterized by oak woodlands composed of small trees on favorable sites but can be oak shrub stands on less favorable sites. The open areas between shrub and tree stands are vegetated with various grasses and forbs.

The vegetative cover for the Gambel Oak Community is summarized as follows:

Ground Cover, Percent:

Bare soil & Rock	1 - 6, mean 4.8
Litter	15 - 48, mean 25.8
Total Non-vegetative	22 - 49, mean 30.6
Vegetative	51 - 78, mean 69.4
Overstory	6 - 71, mean 41.7

Understory Vegetative Cover, Percent:

<u>Bromus marginatus</u>	(mountain brome)	0.7	
<u>Bromus tectorum</u>	(cheatgrass)	0.7	
<u>Elymus glaucus</u>	(blue wildrye)		0.8
<u>Elymus spicatus</u>	(blue-bunch wheatgrass)	11.7	
<u>Elymus triticoides</u>	(creeping wildrye)	1.3	
<u>Festuca ovina</u>	(sheep fescue)	0.3	
<u>Poa secunda</u>	(Sandberg's bluegrass)	3.2	
<u>Balsamorhiza sagittata</u>	(balsamroot)	10.3	
<u>Lathyrus lanszwertii</u>	(thickleaf sweetpea)	6.0	
<u>Mentha arvensis</u>	(field mint)	0.8	
<u>Mertensia</u> sp.	(bluebells)	1.3	
<u>Penstemon</u> sp.	(Penstemon)	0.5	
<u>Senecio</u> sp.	(Senecio)	0.8	
<u>Solidago canadensis</u>	(goldenrod)	1.2	
<u>Wyethia amplexicaulis</u>	(mulesears)	1.0	
unknown forbs		2.5	
<u>Acer grandidentatum</u>	(bigtooth maple)	1.0	
<u>Chrysothamnus viscidiflorus</u>	(green rabbitbrush)	1.3	
<u>Prunus virginiana</u>	(chokecherry)	1.0	
<u>Quercus gambelii</u>	(Gambel oak)	16.5	
<u>Rosa woodsii</u>	(woods rose)		0.8
<u>Symphoricarpos oreophilus</u>	(mountain snowberry)	4.5	

Overstory Vegetative Cover:

<u>Quercus gambelii</u>	(Gambel oak)	12.3
<u>Prunus virginiana</u>	(chokecherry)	0.8

Range Condition: Good

Productivity: 2,400 lbs/acre.

2.5.2.2 Mahogany/Rock Outcrop Community

The Mahogany/Rock Outcrop Community occupies the shallow soils of rocky slopes and mountain crests from about 6,600 feet to 7,960 feet in elevation. Closely associated with this community is the Gambel oak (Quercus gambelii) community. The understory has generally been disturbed by past grazing practices and often consists of mulesears, pepperweed and cheatgrass and scattered sagebrush (Artemisia tridentata). Those mahogany communities in better condition support an understory of bluebunch wheatgrass and a mix of various other perennial grasses and forbs.

The vegetative cover for the Mahogany/Rock Outcrop Community is summarized as follows:

Ground Cover, Percent:

Bare Soil & Rock	18 - 25, mean 21.5
Litter	13 - 29, mean 21.0
Total Non-vegetative	31 - 54, mean 37.5
Vegetative	46 - 69, mean 57.5
Overstory	21 - 24, mean 22.5

Understory Vegetative Cover, Percent:

<u>Bromus marginatus</u>	(mountain brome)	1.5
<u>Bromus tectorum</u>	(cheatgrass)	3.5
<u>Elymus spicatus</u>	(blue-bunch wheatgrass)	1.0
<u>Festuca ovina</u>	(sheep fescue)	4.0
<u>Poa secunda</u>	(Sandberg's bluegrass)	0.5
<u>Allium</u> sp.	(wild onion)	2.0
<u>Lathyrus lanszwertii</u>	(thickleaf sweetpea)	0.5
<u>Lepidium virginicum</u>	(Virginia pepperweed)	1.0
<u>Petrorhiza pumila</u>	(rock goldenrod)	6.0
<u>Wyethia amplexicaulis</u>	(mulesears)	14.5
<u>Artemisia tridentata</u>	(big sagebrush)	2.0
<u>Cercocarpus ledifolius</u>	(curleaf mountain mahogany)	12.5
<u>Gutierrezia sarothrae</u>	(broom snakeweed)	0.5
<u>Quercus gambelii</u>	(gambel oak)	7.0
<u>Symphoricarpos oreophilus</u>	(mountain snowberry)	1.5

Overstory Vegetative Cover:

<u>Cercocarpus ledifolius</u>	(curleaf mountain mahogany)	22.5
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Range condition: good

Productivity: 2,000 lbs/acre

2.5.2.3 Maple/Chokecherry - Riparian Community

The Maple/Chokecherry - Riparian Community varies greatly depending upon the size of the drainage in which it occurs and elevation. Generally, moist side slopes, drainages, and canyon bottom riparian areas have trees and shrubs that grow in dense stands and are taller than the surrounding vegetative community. Where drainages have wide flat channels and floodplains, the deciduous trees can form extensive woodlands. This community varies greatly with respect to composition. Bigtooth maple (Acer grandidentatum) usually dominates on the more mesic northeast-facing hillside sites and in drainage bottoms, and chokecherry (Prunus virginiana) occasionally dominates on slightly dryer northeast-facing hillside sites.

The maple/chokecherry - riparian community in Barneys Canyon is dominated by large stands of maple and/or chokecherry, with scattered gambel oak (Quercus gambelii), douglas fir (Pseudotsuga menziesii) and quaking aspen (Populus tremuloides) intermingling. The understory is comprised of a variety of perennial grasses and forbs.

The vegetative cover for the Maple/Chokecherry - Riparian Community is summarized as follows:

Ground Cover Percent:

Bare Soil & Rock	0 - 3, mean 3.0
Litter	25 - 47, mean 32.7
Total Non-vegetative	25 - 53, mean 35.7
Vegetative	47 - 75, mean 67.3
Overstory	62 - 100, mean 89.3

Understory Vegetative Cover, Percent:

<u>Bromus diandrus</u>	(ripgut brome)	0.3
<u>Bromus marginatus</u>	(mountain brome)	1.3
<u>Carex geyeri</u>	(elk sedge)	2.7
<u>Dactylis glomerata</u>	(orchard grass)	0.3
<u>Elymus spicatus</u>	(blue-bunch wheatgrass)	0.7
<u>Elymus triticoides</u>	(creeping wildrye)	5.3
<u>Achillea millefolium</u>	(yarrow)	0.7
<u>Aster chilensis</u>	(everywhere aster)	1.3
<u>Aster perelegans</u>	(Nuttall aster)	2.3
<u>Lathyrus lanszwertii</u>	(thickleaf sweetpea)	3.0
<u>Mentha arvensis</u>	(field mint)	8.0
<u>Thalictrum fendleri</u>	(Fendler meadowrue)	1.0
<u>Urtica dioica</u>	(stinging nettle)	1.0
<u>Viguiera multiflora</u>	(showy goldeneye)	2.0
<u>Acer grandidentatum</u>	(bigtooth maple)	25.7
<u>Amelanchier alnifolia</u>	(saskatoon serviceberry)	0.3
<u>Prunus virginiana</u>	(chokecherry)	5.0
<u>Pseudotsuga menziesii</u>	(douglas fir)	1.3
<u>Symphoricarpos oreophilus</u>	(mountain snowberry)	2.0

Overstory Vegetative Cover:

<u>Acer grandidentatum</u>	(bigtooth maple)	50.3
<u>Prunus virginiana</u>	(chokecherry)	20.7
<u>Pseudotsuga menziesii</u>	(douglas fir)	1.3
<u>Quercus gambelii</u>	(Gambel oak)	4.0

Range condition: good

Productivity: 2,300 lbs/acre

2.5.2.4 North Slope Douglas Fir Community

The North Slope Douglas Fir Community is mostly confined to the steep north-facing slopes, usually above 6,400 feet in elevation. This community usually consists of large stands of conifer trees with a sparse understory. Snow cover may persist here until early summer keeping the soil moist into the summer season.

In September 1993, field work was conducted to prepare a more detailed map

of vegetative communities for the area of proposed expansion. Modifications were made to the map especially with regard to the North Slope Community (Plate V-C).

The vegetative cover for the North Slope Douglas Fir Community is summarized as follows:

Ground Cover, Percent:

Bare Soil & Rock	1 - 4, mean 2.3
Litter	38 - 71, mean 58.3
Total Non-vegetative	42 - 74, mean 60.6
Vegetative	26 - 58, mean 56.0
Overstory	72 - 85, mean 81.0

Understory Vegetative Cover, Percent:

<u>Bromus marginatus</u>	(mountain brome)	0.3
<u>Thalictrum fendleri</u>	(fendler meadowrue)	0.3
<u>Viola canadensis</u>	(Canada violet)	0.8
<u>Lathyrus lanszwertii</u>	(thickleaf sweetpea)	0.3
<u>Pachystima myrsinites</u>	(mountain lover)	6.0
<u>Physocarpus malvaceus</u>	(mallow ninebark)	3.0
<u>Acer grandidentatum</u>	(bigtooth maple)	4.6
<u>Pseudotsuga menziesii</u>	(douglas fir)	3.0
<u>Symphoricarpos</u> sp.	(snowberry)	3.3
<u>Mahonia repens</u>	(Oregon grape)	14.8
<u>Cercocarpus montanus</u>	(birchleaf mountain mahogany)	1.0
<u>Quercus gambelii</u>	(gambel oak)	3.5

Overstory Vegetative Cover:

<u>Pseudotsuga menziesii</u>	(douglas fir)	70.8
<u>Populus tremuloides</u>	(quaking aspen)	4.5
<u>Prunus virginiana</u>	(chokecherry)	1.8
<u>Physocarpus malvaceus</u>	(mallow ninebark)	2.0
<u>Quercus gambelii</u>	(gambel oak)	1.0
<u>Cercocarpus ledifolius</u>	(curleaf mountain mahogany)	1.0

Range condition: Good

Productivity: 2,000 lbs/acre

2.5.2.5 Quaking Aspen Community

Similar to the Douglas Fir Community, this community is confined to the steep north- and south- facing slopes and drainages of the higher terrain usually above 6,800 feet in elevation, with small colonies existing at lower elevations.

The sites occupied by this community are some of the more mesic areas on the Oquirrh Mountains and usually support large trees with a thick brush, grass, and forb understory. As with the Douglas Fir Community, snow cover may persist here until early summer keeping the soil moist.

The quaking aspen community in Barneys Canyon is dominated by large stands of quaking aspen (Populus tremuloides) with a thick understory of bigtooth maple (Acer grandidentatum) and a variety of perennial grasses and forbs.

In September 1993, field work was conducted to prepare a more detailed map of vegetative communities for the area of proposed expansion. Modifications were made to the map especially with regard to the Quaking Aspen Community (Plate V-C).

The vegetative cover for the Quaking Aspen Community is summarized as follows:

Ground Cover, Percent:

Bare Soil & Rock	1 - 0, mean 0.7
Litter	23 - 48, mean 32.0
Total Non-vegetative	23 - 49, mean 32.7
Vegetative	51 - 77, mean 67.3
Overstory	79 - 99, mean 89.3

Understory Vegetative Cover, Percent:

<u>Bromus inermis</u>	(smooth brome)	1.3
<u>Bromus marginatus</u>	(mountain brome)	1.3
<u>Elymus triticoides</u>	(creeping wildrye)	11.0
<u>Poa reflexa</u>	(nodding bluegrass)	2.7
<u>Asclepias</u> sp.	(milkweed)	0.3
<u>Lathyrus lanszwertii</u>	(thickleaf sweetpea)	3.0
<u>Osmorhiza depauperata</u>	(bluntseed sweetroot)	1.0
<u>Thalictrum fendleri</u>	(fendler meadowrue)	1.0
<u>Verbascum thapsus</u>	(flannel mullein)	0.3
<u>Acer grandidentatum</u>	(bigtooth maple)	25.0
<u>Mahonia repens</u>	(Oregon grape)	0.7
<u>Pachystima myrsinites</u>	(mountain lover)	6.0
<u>Picea pungens</u>	(blue spruce)	0.7
<u>Pseudotsuga menziesii</u>	(douglas fir)	6.3
<u>Sambucus caerulea</u>	(blue elderberry)	0.3
<u>Symphoricarpos</u> sp.	(snowberry)	6.3

Overstory Vegetative Cover:

<u>Acer grandidentatum</u>	(bigtooth maple)	25.3
<u>Populus tremuloides</u>	(quaking aspen)	58.7
<u>Prunus virginiana</u>	(chokecherry)	1.3
<u>Pseudotsuga menziesii</u>	(douglas fir)	2.7
<u>Symphoricarpos</u> sp.	(snowberry)	1.3

Range condition: Good

Productivity: 2,600 lbs/acre

2.6 Wildlife

The project area is located in the mountain brush zone of the Oquirrh Mountains. Included within this broad plant zone are the widespread gambel oak community, the mountain mahogany community on rock outcrop sites, the conifer stands on the steep north slopes, the aspen community at the higher elevations, and the riparian tree community in the major drainages. All of these communities are considered high value wildlife habitats.

The wildlife data was gathered over several survey periods (1987, 1991, 1993) during soil and vegetation surveys. Also, a raptor nest survey was conducted in the fall of 1993. From these sources, a large quantity of qualitative data has been accumulated on the wildlife populations and wildlife habitats of the project areas.

The restricted access and the removal of livestock grazing has allowed wildlife to fully utilize the area with a minimum disturbance and sufficient forage and cover.

2.6.1 Elk

Elk use the area year-round, wintering on the exposed ridges and lower elevations in the gambel oak and mountain mahogany communities. They summer at the highest elevations of the mountain brush zone. Elk numbers are unknown but they are common on the respective use areas. The most critical areas for elk are the calving habitats.

The calving habitats are defined as dense shrub and tree cover with herbaceous and graminoid ground cover sufficient to conceal calves. These habitats are generally confined to northerly aspects in drainages or concave portions of the slopes where mesic conditions provide for optimal plant growth. The plant communities are aspen and conifer or more specifically the ecotone between these communities where several layers of plant growth provide the necessary cover and seclusion.

2.6.2 Mule Deer

Deer also use the project area year-round in a manner similar to Elk. Deer may winter at lower elevations than elk, in the oak and sagebrush communities, because of their inability to negotiate deep snows. Deer are very common in all habitats as the mountain brush zone is the most productive habitat for mule deer in Utah. Deer fawn in areas of heavy ground cover, and in addition to the elk calving habitats described above, would also utilize the heavier oak/maple stands in the concave sites on the slopes and in the riparian zones.

The lack of surface water in much of the project area limits the use of some potential fawning habitats especially during years of below-normal snowfall. Most of the deer summer near the main ridge of the mountains at the higher elevations of the project area due to springs located close to the main ridge.

2.6.3 Predatory Mammals

Coyotes and lions are probably the most common predators in the mountainous habitats. Lions, while very secretive, have been observed in the area. They are attracted to the plentiful large mammal prey supply in a secluded area.

Coyotes are also very common and utilize a wide variety of prey.

The mammalian prey base consists of cottontail rabbits, ground squirrels and tree squirrels, wood rats, mice, voles, and shrews.

2.6.4 Raptors

Large raptors, such as eagles and buteos (large soaring hawks), utilize the large open, mature conifers as roost sites. From observations over the years in the Oquirrh Mountains and recently at Barney's Canyon, large raptors hunt in the valleys and foothills but return in the evening to the high elevations of the mountains to roost. The large open trees and cliffs provide a safe roost site away from disturbance.

The lack of large nests in Barney's Canyon is probably due to the lack of cliff habitats and large open mature conifers. Most of the conifers in the area are second growth or stands on poor sites. These younger or smaller trees lack the open growth type that would be used by large nesting raptors. All of the open mature conifers identified in the survey were searched carefully for nests.

The smaller raptors, more specifically the kestrel falcon and the cooper's hawk, are the more common raptors in the mountain brush zone. They prefer this habitat due to the large variety of small bird populations and protective cover of large shrubs and small trees. The multiple layers of plant cover common to the mountain brush zone provide niches for a large variety of birds (which serve as prey for raptors), increasing the density of birds per acre over most other habitats.

The raptor nest survey did not reveal any nests of large raptors. The nests located were of the smaller raptors, especially cooper's hawks, that nest in trees in drainages and hunt in the tree and shrub plant communities for small prey. These small nests are not easy to locate and additional small nests may be present in the area due to the abundance of sites in this area. Kestrel falcons nest in tree or rock cavities. None of these raptors are considered endangered species.

Owls, common in the mountain brush zone, include the small screech owl and the flammulated owl, and the larger great-horned owl. Most owls prey on small mammals and medium-sized mammals that inhabit this habitat type; however, the flammulated owl is insectivorous. Owl populations in the project area are unknown due to the lack of surveys specific to detecting owls. Owl nests are rarely observed during raptor nest surveys due to the secretive nesting habitats and nocturnal hunting habits of owls.

3.0 OPERATION PLAN

The locations of the various project facilities are shown on Figure 1.1-1 and a detailed layout is presented on Plate I-B. The project consists of five open pit mines and their associated dumps, ~~two sulfide waste rock repositories~~, a crushing plant, ~~a sulfide flotation plant~~, heap leach facilities, a carbon adsorption, desorption and regeneration (ADR) plant, a gold refinery and necessary support facilities.

Peak employment for the project is estimated at 210. Approximately 85% of the work force will work during any 24-hour period. The remainder of the personnel will be off. Slightly less than 50% of the work force works the day shift and the remaining employees man the afternoon and night shifts.

Employees reach the project site via the access road from State Highway 48, and the employee parking lot is located at the administration building. Employees working at the truck shop, the mine pits, the crushing plant, leaching facilities and process plant are transported to these locations in crew-transport mini-buses.

~~Mining at the Melco Pit began in 1989 and will continue until approximately December 2001. Mining at the Barneys Pit began in February 1989 and ended in August 1996. All other pits are now inactive. It is anticipated that active leaching and gold recovery from the ore pads will continue for several years after the mining and milling facilities are closed.~~

~~Commencing in 1993 Kennecott will mine two recently discovered ore bodies, the North BC South and South BC South deposits. The South Barneys Pits which are located between the Barneys Canyon and Melco Deposits, were mined between April 1993 and December 1995 (Figure 2.1-1). In addition, Kennecott will increase the size of the Melco Pit to extract additional ore reserves discovered as a result of on-going exploration. The locations of these planned operations are shown on Figure 1.1-1.~~

~~Access to these project areas is the same as described above. However, Two short segments of the Melco access road will be were realigned to allow for the construction of the North BC South and the South BC South pits. The segment passing through the North BC South pit will be was relocated prior to commencement of overburden removal at South BC South to maintain access to the Melco area and will result resulted in no additional disturbed area (Plate II-B). The access road will be was routed to the south of the North BC South deposit where it will be was constructed on fill generated during mining of the South BC South deposit (Plate II-B).~~

Commencing in the 1st quarter of 1994 Kennecott will begin ~~began~~ construction of a sulfide flotation plant located next to the existing crushing and conveying infrastructure (Plate II-C). Approximately two million tons of "ore grade" sulfidic material will be liberated as a by product of oxide mining and treated through this flotation plant. Previously these tons would have been treated as waste and blended with oxide waste in the dumps.

The sulfide plant will ~~utilize~~ utilizes the existing oxide coarse crushing plant to reduce approximately 8,000 tons per week of sulfide ore to minus 1.5 inch size. Fine crushing and grinding units will produce feed to a flotation plant where approximately 45% of the gold and over 90% of the sulfur (which was originally in the range of 2%-5%) will report to the

concentrate. After dewatering, the concentrate (29,000 tons/year) will be shipped offsite for further processing.

The tailings from the flotation plant, containing the remaining 55 percent of the gold, will be partially dewatered and blended with dry oxide ore on the existing agglomerating conveyors for heap leaching.

~~Commencing in 1997 the East Barneys pit will be mined. The East Barneys Pit was mined between April 1997 and August 1998.~~ Haulage access ~~will be~~ was built from the East Barneys pit exit to a road currently used to access the topsoil stockpile, then continued along that existing road to the Barneys Canyon haul road. The second part of the road ~~will be~~ was widened to accommodate mine haulage equipment.

3.1 Description of Mineral Deposits

The gold in the Barneys Canyon deposit is hosted in sandy dolomite and sandstone. The ore in the Melco deposit is contained in quartzites and to a lesser extent in calcareous sandstone. The geology of the Barneys Canyon and Melco mineral deposits is described in detail in Section 2.1.2. The Barneys deposit is a sub-horizontal occurrence of gold ore that is highly variable in thickness and overlain by zero (0) to perhaps 400 feet of overburden. Maximum pit depth is planned to be approximately 750 feet. The general geometry of the ore deposit is shown in plan and in cross section in Figure A-I-1 which is found in Appendix A (CONFIDENTIAL). The Melco deposit is a near-vertically dipping ore deposit that is somewhat elongate in plan, as Figure A-I-2 in Appendix A (CONFIDENTIAL) shows. The Melco ore body is exposed at the surface; however, removal of overburden above and adjacent to the ore body will result in a pit with a maximum depth of approximately 1000 feet.

The North BC South and the South BC South ore bodies are hosted in sandstone of the Kirkman-Diamond Creek Formation near the basal contact with the orthoquartzite of the Freeman Peak Formation (orthoquartzite). Gold mineralization is hosted in moderately northeast-dipping clay-rich zones of slip and brecciation within interlayered sandstone and orthoquartzite.

The rock sequence is similar to that at the Melco deposit, but, unlike Melco, the BC South ore bodies are almost totally oxidized with minor sulfides (less than 1 %) remaining. Overburden at both deposits consists of sandstone and orthoquartzite which are locally altered to clays. Exploration drilling encountered no water within the limits of the proposed North BC South pit, and only minor amounts of perched water at the South BC South pit (see Section 2.3.1).

Geologic cross sections A-A' (Figure 2.1-9), B-B' (Figure 2.1-10), and C-C' (Figure 2.1-11) depict the geology of the Melco, South BC South, and North BC South ore bodies, respectively. The ultimate pit outlines are also shown on the cross sections. Lines of section are shown on the geologic map (Figure 2.1-1).

The East Barneys deposit is hosted in the Kirkman-Diamond Creek sandstone. Gold mineralization is hosted in moderately dipping, clay-rich zones of slip and brecciation within

interlayered sandstone and orthoquartzite. The rock sequence is very similar to that of the BC South deposit, however, the orebody is totally oxidized. The deposit is overlain by about sixty feet of the Quarternary alluvium composed of sandstone, quartzite and limestones. A

Geologic cross section of the East Barneys deposit showing the final pit outline, is denoted as section D-D' on Figure 2.1-12 and included as Figure 2.1-14.

3.2 Mining

The Barneys Canyon project, prior to 1993, consisted of two separate open pit mines, the Barneys pit and the Melco pit. The locations of these pits are shown on Plates I-A and III-A. The Barneys Canyon pit is located at an average elevation of 6,600 feet AMSL on predominantly south-facing slopes which form part of the north wall of Barneys Canyon. The Melco pit, located 1.5 miles southwest of the Barneys Canyon pit, occurs near the headwaters of the right fork of the Dry Fork Creek drainage, a tributary to Bingham Canyon. The Melco pit site is on a south-facing slope at an average elevation of 7,400 feet.

In 1993, the project involves expansion of will expand the existing Melco pit was expanded and develop two new deposits, known as the North BC South and the South BC South pits were developed. The locations of the pits are shown on Plate II-B. The North BC South and the South BC South pits are located along the Melco haul road at an average elevation of approximately 6600 feet. In 1997 the East Barneys pit, located at an elevation of 6100 feet was developed and the Melco Pit was again expanded.

The Melco pit will be expanded and the During the 1993 and 1997 expansions, the bottom of the ultimate Melco pit was lowered to approximately 6460 5480 feet AMSL to allow extraction of additional ore reserves at depth. A series of new waste dumps will be are being constructed north of the pit in Barneys Canyon. Annual ore production will be has been maintained at the 2.6 million tons per year rate while the average annual waste production will increase was increased to approximately 18.5 million tons during 1994 through 1998. The Melco expansion extends the life of the project approximately 3-1/2 years.

The North BC South pit will be expanded and the bottom of the pit lowered to approximately 6460 feet AMSL. The additional waste rock generated by mining the larger pit will be used to cap the existing BCS waste dump and continue backfilling the SBCS pit.

The East Barneys Pit is located near the Barneys pit haul road at an average elevation of 6100 feet. Waste rock will be dumped into the existing Barneys Canyon Pit. (Figure 3.2-12 and Plates 96-5 and 96-6)

3.2.1 Mining Operations

The Barneys Canyon mines operates 52 weeks per year and 7 days per week on two 12-hour shifts per day. The maximum average ore production rate is approximately 7,000 tons per day.

Work to date at the mine sites has consisted of exploration drilling, construction, and mining of overburden and ore at the Barneys Canyon and Melco Phase A pits. Initial overburden removal began in February, 1989 Mining of the Melco Phase A pit commenced in October, 1989 and was completed October, 1990. Prior to commencement of mining activities, the topsoil at each pit was removed and placed in topsoil stockpiles. Topsoil management plans are presented in detail in section 3.7. Vegetation was also removed.

Ore and waste is mined by drilling and blasting, loading, and truck transport to the

crusher and mine waste dumps, respectively. The blast hole drilling program serves the additional purpose of providing samples for analysis for grade control. The gold analyses are performed at the on-site analytical laboratory. Drilling is conducted with either tracked or rubber-tired, 360-horsepower diesel air drills. Blast holes are drilled approximately 20 feet deep on 16-foot centers with blasting taking place only during the day shift. An average of about 30,000 tons of ore and waste are blasted per day. Blasting is conducted so as to minimize noise and vibrations. Up to a total of 136 An average of 109 blast holes may be drilled, loaded, and shot per day. Ammonium nitrate/fuel oil (AN/FO) is the primary explosive agent and is supplied to the blast areas in bagged or bulk form by truck.

Blasted ore and waste are loaded with a Cat 992 C front end loader. The excavators generally do not require dozer assistance. The excavators load ore and waste into 55 and 85-ton-class, off-road-type haul trucks. Run-of-mine (ROM) ore is hauled to an ore stockpile which is are located at the crusher. The crusher is located northeast of the Barneys Canyon pit and consists of primary and secondary crushers, screens, and agglomeration facilities. The average haul distance to the crusher from the Barneys Canyon pit is approximately 1.5 miles. Run of mine ore from the Melco pit was is transported approximately 4.5 3.5 miles to the crusher stockpile by 85 ton rear dumphaul trucks.

Waste rock, or overburden, from the Barneys Canyon pit is was hauled in haul trucks to one of three mine dumps located north and east of the open pit, as shown on Plate III-A. Waste rock from the Melco pit is hauled to the mine dump located southeast of the pit (Plate III-A). Average waste hauling distances for the Barneys Canyon and Melco waste rock are was approximately 1.0 mile.

Fugitive dust emissions on haul roads are suppressed by application of water by two 350-horsepower, 8,000 gallon water trucks equipped with six sprays. The water trucks operate as required for dust control.

Dumps are created by end-dumping waste from the haul trucks. The dumps are constructed in lifts of up to 500 feet in height at Melco and 300 feet at Barneys, each with slope angles of 37 degrees. Track-type dozers are used to assist in pushing waste rock over the dumps.

Other operations that take place as part of mining include grading of road surfaces by 150 horsepower motor graders and general housekeeping and materials handling functions. In addition to initial construction of haul roads, on-going construction of drill pads and haul roads will take place throughout the life of the mine. Road construction is carried out by two 370-horsepower, tracked dozers, with drilling and blasting used where necessary.

As of December 31, 1992 approximately 8.24 million tons of ore and 27.65 million tons of waste have been excavated from Barneys Canyon and Melco mines.

In 1993, the mining operations resumed at Melco, and commenced at North BC South, and South BC South pits.

Waste rock from the Melco pit will be hauled to one of three waste dumps located east, southeast and south of the pit, as shown on Plate II-B. The maximum one-way waste haul distance from the Melco pit is approximately 2 miles. Waste rock from the North BC South pit will be was hauled and used to backfill the South BC South pit. Waste rock from

the South BC South pit will be ~~was~~ hauled to a waste dump located east of the mine in an ephemeral tributary to Barneys Canyon (Plate II-B). Approximate one-way waste haul distances from the North BC South and the South BC South pits are ~~were~~ 0.5 and 0.6 miles, respectively.

Waste rock from the Melco pit will be ~~is~~ dumped to the north and south of the pit as show in Plate II-C. Construction of a haul road from the north side of the Melco pit to the North BC South pit will ~~shortened~~ the ore and waste hauls. The Melco southern dumps (formerly the 7200 Dump) will be ~~are~~ constructed in lifts of up to 1000 feet and will be modified from that already permitted to improve drainage. The Melco north dumps will be ~~are~~ constructed in lifts up to 500 feet in height. ~~Other mining operations will remain essentially the same.~~

~~Annual ore production will be 2,600,000 tons. Average annual waste production during the years 1992 through 1995 is expected to be 10,500,000 tons.~~

East Barneys Waste rock consists of about 500,000 tons of alluvium and 500,000 tons of sandstone, quartzite and limestone. Waste will be ~~was~~ dumped into the existing BC Pit as backfill.

The ~~East Barneys~~ Pit will ~~disrupted~~ the surface drainage pattern in the bottom of Barneys canyon. The ~~A~~ diversion ditch will be ~~was~~ designed and built to contain a 10 year, 24 hours storm event. Water collected in the ditch will be ~~was~~ diverted through an engineered ditch located along an upper bench of the pit and discharged back into the existing drainage downstream of the pit. The design and flow calculations of the diversion ditch (attachment DII(a)) was prepared by the Barneys Canyon Mine to carry the flow from the 10-year, 24-hour precipitation event for the Barneys Canyon watershed uphill from the diversion. The design flow of 4 cfs was calculated by JBR Environmental Consultants for the November 11, 1993 NOI submitted to DOGM by the Barneys Canyon Mine. Appendix D-II of that document will provide the background information for the calculation of the design flow.

~~The riprap designs for the outlet of the diversion ditch and the culvert under the East Barneys pit access road have been prepared by JBR. The design flow velocity for the outlet of the ditch was provided by the Barneys Canyon Mine as 5.68 fps. We recommend that the flow of 4 cfs at 5.68 fps be discharged from the end of the ditch onto a bed of riprap having a D_{50} of 4 inches. The riprap bed should be built between the outlet of the ditch and the inlet of the culvert under the East Barneys pit access road. The riprap bed should be approximately 1.5 feet thick and should inlaid into the receiving soil so that the top surface of the riprap bed is at the same elevation of the bottom of the ditch.~~

~~We calculate that the velocity of the water (4cfs) exiting the 24-inch diameter culvert under the access road would be approximately 8 fps. The riprap bed at the end of this culvert should be 6 feet wide by 17 feet long, having a D_{50} of 4 inches and a thickness of 1.5 feet. If the slope or channel downstream from this riprap bed is subject to erosion, the same riprap could be extended down slope as necessary.~~

At completion of mining, the diversion basin will be ~~was~~ breached, resulting in surface water flow into the pit. Water that does not evaporate or soak into the soil will collect in the pit, which will be about 60 feet below the canyon bottom. If the pit fills, water will flow

downstream into the existing drainage.

3.2.2 Pit Slope Stability Analysis

The locations and maximum extent of the Barneys Canyon and Melco Phase A pits are shown on Plate III-A. The locations and the maximum extent of the North BC South, South BC South and the expanded Melco pits are shown on Plate II-B. Each of the pits will be developed with 20 foot benches. Safety catch benches with a minimum 27-foot width will be left every 60 feet. Median bench face angles are expected to be 75 and 76 54 degrees for the Barneys and Melco Phase A pits, respectively. A maximum interramp or overall pit slope angle of 47 degrees results from this configuration, shown on Figures 3.2-1 and 3.2-2. The interramp slope design at the Barneys Canyon pit is designed at a uniform 47 degree interramp angle. Present surface topography and ultimate pit cross sections for the Barneys and Melco Phase A pits are shown in Figures 3.2-3 & 4, and 3.2-5 & 6, respectively.

Median bench face angles are expected to be approximately 64 and 58 degrees at North BC South and South BC South respectively, and approximately 64 degrees at the Melco expansion. An overall pit slope angle of 47 degrees is expected at Melco, angles ranging from 39 to 47 degrees are expected at North BC South (Figure 3.2-7), and South BC South is expected to have an overall slope angle from 39 to 41 degrees (Figure 3.2-8). The design pit configurations for the Melco, South BC South, and North BC South pits are shown on figures 3.2-9, 3.2-10, and 3.2-11, respectively. Ultimate pit cross sections for the North BC South, South BC South, and Melco expansion pits are shown in Figures 2.1-9, 2.1-10, and 2.1-11, respectively. The slope angles described above are approximations and will vary somewhat based upon rock types and other field conditions.

Pit wall slopes in the East Barneys pit will average 47 degrees on the north wall and 37-39 degrees on the south wall. Lithology Bedding is orientated similar to the North Barneys Canyon pit, dipping at about 30 degrees to the north east. Pit walls on the east and west walls were will be dictated by haulage access and are will be well below the angle of repose. Figure 3.2-12 shows the East Barneys pit design. Bench face angles are expected to be 64 degrees in the bedrock and 45 degrees in the alluvium.

Pit slope stability has been analyzed by geotechnical consultants, Call and Nicholas. Rock fall and large-scale slope failures were considered. As a result of this analysis, 27 foot wide safety catch benches are were constructed every 60 feet down the pit highwall.

The stability analysis indicated that large-scale slope failures are unlikely. The mine will be operated in accordance with all Federal Mine Safety and Health Administration (MSHA) guidelines and standards from mine safety, which include requirements for pit slope stability.

3.2.3 Carbonaceous Ore Stockpile

The Melco ore body contains identified zones of carbonaceous sulfide mineralization. The revised 1993 and 1997 revisions to the mining plan for the Melco pit has resulted in a larger pit than was previously contemplated or permitted. Approximately 1,100,000 tons of carbonaceous ore from a zone near the base of the ore body will be mined. These carbonaceous rocks contain low-grade gold mineralization, but cannot be readily processed by heap leaching methods and may not be economical to process by flotation. Kennecott

has evaluated several alternatives for processing these ores, which will be have been stockpiled at a site on the South Melco mine dump until they can be processed. The location of these planned ore stockpiles are shown on Plate II-B. If the stockpiled carbonaceous ore cannot be economically processed, the stockpiled material will be placed in the Melco waste rock dumps and covered with waste rock, either the Melco or NBCS sulfide repository.

~~The carbonaceous ore stockpile will be rehandled and processed through the sulfide flotation plant.~~

Kennecott has secured approval of its plan for handling the sulfide ore stockpiles from the Division of Water Quality (DWQ). A copy of the correspondence describing this plan is provided in Appendix J.

3.3 Crushing, Screening, Conveying and Stockpiling

The crushing plant receives run-of-mine ore and delivers crushed, agglomerated ore for constructing heaps. The crushing operation is depicted on the flow diagram in Figure 3.3-1. The limits of the crushing plant extend from the stockpile to the heaps constructed by the radial stacker. Fifty-five or 85-ton ore haulage trucks transport ore to a stockpile located adjacent to the primary crushing plant. A rock breaker is used to break oversized rocks. Ore is reclaimed from the stockpile by a Caterpillar 988B front-end loader and placed in a 35-ton crusher feed hopper which discharges to a vibrating grizzly feeder.

Grizzly oversize (bar separation is five inches) falls through an enclosed chute directly into a 42-inch x 48-inch primary jaw crusher. In the primary crusher cavity, ore up to three feet in size is crushed to minus nine inches. Grizzly undersize is discharged through an enclosed chute onto a 48-inch x 232-foot belt conveyor leading to the secondary crushing plant. Size reduction in the primary jaw crusher occurs at a four-inch closed-side setting. Jaw crusher and grizzly undersize products are combined and transported via a 48-inch conveyor to an eight-foot x 20-foot double-deck vibrating screen. Capacity of the crushing facility is 650 dry short tons per hour. Oversize from both screen decks is conveyed by a series of 36-inch conveyors to a five-and-one-half-foot standard cone crusher which is operated in closed circuit with the screen to produce minus one-and one-half-inch product.

Cement from a 150-ton capacity silo is dumped at a controlled nominal rate of around 7.5 pounds per ton to the minus-one-and-one-half-inch screen undersize product. The combined ore-cement mixture is transported via a conveyor to the five 36-inch x 20-foot agglomeration conveyors. Water is added by sprays on the five conveyors to produce an agglomeration product suitable for heap construction. Agglomeration is a technique that combines the water and fine cement with the ore to facilitate improved leaching and gold extraction. The moisture content of the agglomerated ore is controlled to approximately 10 to 12 percent. The agglomerated ore is transferred from the crushing plant to the upper edge of the leach pad area via interconnecting 36-inch overland conveyor belts. The last overland conveyor discharges onto the first of a series of 28 portable 100-foot-long conveyors for subsequent feed to a 100-foot radial arm stacker via the transfer conveyor and a shuttle type stacker feed conveyor. The stacker progressively retreats up the leach pad to spread agglomerated ore evenly on top of the overliner blanket or previous lift. Cyanide solution is sprayed on the ore to initiate the leaching of gold.

Initial plans called for the crushed and agglomerated ore to be stacked in three lifts of 17 feet

each to a total height of 51 feet. The specified lift height may be increased or decreased in the future depending on metallurgical results. The identification of additional ore reserves has caused the maximum ore heap height to increase to 175 feet. is limited to 125 feet.

To ensure heap stability, as progressive lifts are stacked, the toe of each new lift is set back a pre-determined distance from the crest of the prior lift around the full periphery of the pad.

Water sprays at conveyor transfer points are part of the dust suppression system that controls both moisture content and air quality.

Sulfide ore is will be batched through the existing crushing plant on a weekly basis and conveyed to a 5,000 ton live capacity enclosed stockpile. The planned annual combined ore tonnage will consist of approximately 417,000 tons of sulfide ore and 2,183,000 tons of oxide ore for a total of 2.6 million tons per year.

Sulfide ore is will be reclaimed from the stockpile at a nominal 1,200 tons/day with belt feeders in a reclaim conveyor tunnel. This conveyor will feeds a 3 foot Nordberg water flush cone crusher which will discharge into the ball mill sump. Grinding will be accomplished with a ball mill.

The concentrate is will be produced in standard mechanical flotation cells, cleaned in a column cell, and reground if necessary. The concentrate will be is dewatered in a thickener with a vacuum filter to ensure a proper solids density. The tailings are will be metered back to the agglomerating conveyors for blending with the oxide ore stream enroute to the heap leach pads. A generalized site map, flowsheet and building layout are included as Figures 3.3-2, 3.3-3 and 3.3-4.

3.4 Leaching

Ore is transferred from the crushing area to the leach pads in a series of fixed overland conveyors. The radial stacker heaps the ore into 17-foot-high lifts on the previously prepared leach pads. The ore is then sprinkled with a weak (0.3 pound NaCN per ton of leach solution) sodium cyanide and sodium hydroxide (NaOH) solution. Wobbler-type spray heads are used. The solutions leach the gold from the ore as they percolate through the heaps. The resulting "pregnant solution" is collected on the pad and piped to a lined pregnant solution pond located adjacent to the process plant at the east end of the property. Pregnant solutions from the pond are pumped to carbon columns located within the process building, where carbon adsorption takes place. The loaded carbon columns are then processed further through desorption, electrowinning, and refining. The leach pads, solution ponds, and process building locations are shown on Plate 96-1.

3.4.1 Leach Pads

A total of approximately 270 acres of pad area is required over the life of the project. The leach pads currently cover about 183 acres. The pads have been designed and approved by DWQ for a maximum ore height of 125 175 feet. To reduce capital outlay, the pads are have been constructed sequentially as needed with the first (BC-1) leach pad constructed in 1989. As of February 1997, pad BC1, BC2, BC3, BC4, and BC5 were all operational. Other pads expansions will be constructed as required. in later years. The general arrangement of the leaching facility is shown on Plate 96-1. A generalized drawing

depicting the major components of leach pads is shown on Figure 3.4-2. Leach pads ~~are~~ will be sized and arranged on the site to reduce the amount of grading required for pad foundations.

Leach Pad Foundations

Each pad is first graded to produce a firm foundation. Grading is preceded by vegetation and topsoil removal. The topsoil is placed in stockpiles for future use in reclamation of the facilities. The pad foundations are built with cut and fill techniques where the alluvial soils are excavated from the ridges and placed in the low spots as engineered fills. The backfills are raised in horizontal lifts not exceeding 8-inches in thickness, conditioned with moisture and compacted to 90-95% of maximum dry density (see Appendix E for full specification). The general grade of the pad foundations slope along their long dimensions at 6% maximum and less than 1% along their short dimensions so that each pads lowest point is in a corner for efficient solution collection (Figure 3.4-3). (Stability analyses performed by Sergeant, Hauskins and Beckwith (1988) indicated that the heaps ~~will~~ would be stable.) The detailed grade of the pad surfaces ~~will~~ typically accommodate the topography through the use of long terraces which themselves have slopes along their long and short dimensions for drainage of solutions (Figure 3.4-3). The final foundation grade forms a sub-base with a permeability of less than or equal to 1×10^{-6} cm/sec upon which a leak detecting system is placed.

At the downhill margins of the pads, the pad surface terminates in a solution collection trench that is 11-feet wide at the crest and 2 feet deep. Outside of the trench, there is a perimeter berm that is 2-feet high with an 8-foot wide toe (Section A, Figure 3.4-3). The bottom corner of each leach pad cell is equipped with a leachate collection pipe extending through the perimeter berm (Detail 6, Figure 3.4-4). This pipe is made of welded HDPE and transports the collected solutions to the leach pads.

Liner Leak Detection System

A Six-inch-thick, high permeability pad drainage system is installed above the compacted low-permeability subgrade. The purpose of the leak detection system is to alert operations personnel to solution losses through the HDPE and clay liners. Typical cross sections of the pad lining and leak detection system are shown on Figure 3.4.3.

Leak detection under all areas of the pad is accomplished by monitoring the presence of any solution flow in a closed HDPE collector pipe which connects to a series of two-or three-inch-diameter corrugated polyethylene pipes resting on the subgrade (Figure 3.4-5).

Each pipe exits at the side of the pad. The leak detection pipes are factory-milled with 0.66-inch-wide slots placed on 40-foot centers. A minimum slope of one percent is maintained on the leak detection pipes. Each six-inch HDPE collection pipe at the margin of the leach pads is joined to the non-perforated end of the leak detection pipe by a polyethylene snap adapter. The other end of the non-perforated leak detection pipe is joined by a pipe sleeve to its perforated equivalent that rests on the leak detection layer.

Leach Pad Liners

The secondary earth liner is placed on top of the leak detection system. This is a fine-grained clay soil borrowed from the property near the leach pads. It is spread in layers that

when compacted ~~are~~ will be approximately 6 inches thick, conditioned with water and compacted to 95% of the maximum dry density as determined under ASTM-D698 (see Appendix E). Two layers are placed for a total compacted thickness of 1 foot. The permeability of this compacted soil liner is 1.0×10^{-7} cm/sec which, combined with the design thickness, ensures that any seepage through the primary plastic liner is essentially stopped by the secondary liner. This liner is extended to the perimeter berms as shown on Figures 3.4-3. The clay for the secondary liner is recovered from borrow pits on the Barneys Canyon property. Three borrow sources have been identified thus far and their locations are shown on Plate III. Further pit development will depend on the resources available at each of the existing sites ~~and the amount of clay required for future pad expansions~~. ~~Clay pits 1 and 2 have been finished and reclaimed. Clay pit 3 has been partially developed.~~ The extent of current development and estimated ultimate pit size is shown on Plate III-A. ~~Pits will be expanded or developed as demand for liner materials arise.~~

The primary liner is immediately placed on top of the earth secondary liner. The primary liner is 60 mil HDPE installed according to the manufacturer's recommendations (see Appendix F for full specification). This material covers all interior areas of the pads, as shown of Figures 3.4-2 and 3.4-3.

Solution Collection

The final step in pad construction is the installation of the crushed ore blanket, or overliner, on top of the primary liner. Solution collection piping is installed on each cell prior to covering the liner with overliner. The piping consists of a three-inch-diameter corrugated, perforated polyethylene pipe spaced at 40-foot centers (Figure 3.4-2). These pipes connect to an eight-inch-diameter polyethylene collection main which runs downslope to the discharge end of each cell. The blanket is minus 1 1/2-inch crushed ore, produced at the plant crushing facility, which will be trucked or conveyed to the pad and spread to a thickness of approximately 4 feet. The overliner functions as a protective cushion separating the primary plastic liner from the overlying ore. The crushed and agglomerated ore is then be stacked on top of the cushion.

3.4.2 Solution Conveyances

Leach solutions draining from the bottoms of the heaps flow in pipes in the solution collection trenches along the margins of the pads to the low points of each cell where the solutions are routed into HDPE pregnant solution pipes. The pregnant and barren solution pipes have secondary containment, a lined ditch which flows toward the process solution ponds. Pregnant solutions entering the ponds are routed through measuring flumes that record the flow rates.

The collection trenches are HDPE lined ditches from the pads to the solution ponds to collect any leaks of solutions from the pipes, as shown on Figure 3.4-4. These collection trenches are separated from the general site drainage by their lateral berms and carried under all road crossings with culverts. The layout of the trenches provide suitable grade (1% minimum) so that any leakage is conveyed in the trenches back to the process solution ponds (Figure 3.4-4).

The barren solution piping system on the heaps consists of a 12-inch HDPE pressure main on each cell, a network of six-inch PVC branch lines, and a network of three-inch spray

PVC lines spaced at 40-foot intervals. The sprinklers are "Senninger-Wobblers" spray heads. The Senninger-Wobbler sprinkler is highly resistant to corrosion which reduces the risk of plugging or stalling. Since it has a single moving part, the Wobbler also resists wear.

The spray heads operate between 15 and 25 pounds per square inch and provide a solution application rate of .0025 to .004 gallons per minute per square foot of pad area. Yelomine SDR-21 PVC is employed using spline connections. The piping system is inspected daily by the leaching crew. The Wobblers require occasional un-blocking of orifices. The leaching crew surveys the spray pattern and note non-performing sprinklers. After shutting down the feedlines, the sprinkler is unplugged or replaced. The sprinkler system is restarted after maintenance is completed.

Solution pumping is accomplished with submersible-type pumps in the solution ponds. Outside of the solution process building, pumped solution pipes are equipped with pressure sensors which immediately and automatically shut down the pump should there be a significant break in the pipeline.

3.4.3 Solution Ponds

The process solution ponds are HDPE-lined basins located at the lowest point in the process area (Figure 3.4-1). The ponds will have a total capacity sufficient to contain the following volumes:

- 1) The working inventory of leach solution. This is the combined volume of solutions in the pregnant barren and intermediate ponds. Normal volume is 4,000,000 gallons in each pond (12,000,000 gallons total).
- 2) The drainage of leach solution from the connected heaps during a 24 hour shutdown of the leach pumping system. The calculation assumes a 24-hour draindown volume enters the ponds at the prevailing barren solution pumping rate to the heaps. For example, at a pumping rate of 2000 gpm, the calculated volume would be 2,880,000 gallons.
- 3) The volume of runoff from the exposed, lined pad and trench areas that occurs during the 100-yr 24-hour precipitation event. This is based upon 3.5 inches of rain. This runoff will be a variable and will equal 218,200 gallons for each 100,000 square feet of bare plastic.
- 4) The runoff from the leach pads. Due to the water storage capacity of the heaps, it is assumed that runoff occurs only from areas under active leach. Runoff from the 100-year storm (3 1/2 inches of rain) would provide 218,200 gallons for each 100,000 square feet under active leach.
- 5) The direct precipitation on the ponds during the 100-yr 24-hour precipitation event. This will equal 403,670 gallons based on 3.5 inches of rain falling on the 185,000 square foot pond area.
- 6) A freeboard value of at least 2 feet above the level for volumes 1) through 5) above.

The combined capacity of the barren pregnant and intermediate solution ponds is available for the draindown and storm inflows. The total capacity of the process solution ponds is 15,200,000 gallons.

The ponds have 3h:1v sideslopes and bottoms that are sloped to one low corner (Figure 3.4-6 and 3.4-7). The bottoms of the ponds have a rectangular configuration and are inclined at 2.0%, then graded to one corner where the pond leak detection collection sump is placed (Figure 3.4-7)

The ponds were first excavated to approximate final grade. Twelve inches of secondary liner material was then applied in two 6-inch compacted lifts (Figure 3.4-6). The permeability, material type, and placement techniques for this liner material were identical to those described for the leach pads in Section 3.4.1. A geotextile followed by a drainage grid material was then placed on the secondary liner (Figure 3.4-6). The primary liner of 60 mil HDPE was then placed on top of the drainage grid and anchored in trenches along the margin of the ponds (Figure 3.4-6).

The function of the drainage grid is to capture any leaks that might occur through the primary liner and allow leakage to be drained to the low point of the pond bottom for removal. The low point of the leak detection system is equipped with a small sump to collect the seepage. Eight-inch diameter standpipes are used to monitor the leak detection sumps for leakage (Figure 3.4-6). A probe inserted in the standpipe detects any solution accumulated in the leak detection sump. If confirmed that the solution is leakage from the ponds, the DWQ will be notified as required in their construction permit.

3.5 Leach Solution Processing

Leach solutions are processed in the process building. The building's location is shown on Plate III. A leach solution processing is depicted on the flow sheets shown on Figures 3.5-1 and 3.5-2.

3.5.1 Carbon Adsorption

The carbon adsorption process is depicted on Figure 3.5-1. The leach solution from the pregnant solution ponds is pumped to carbon columns, each filled with granulated, activated carbon, and located in the process building. The gold-cyanide complex is adsorbed on the carbon as the pregnant solution passes through the columns. The solution coming from the carbon columns is the barren solution and is refortified with solutions of NaOH and NaCN and recycled to the barren solution pond. The barren solution is then pumped back to the heaps to complete the leach cycle. Fresh water as needed is added to the barren ponds to make up for evaporative losses from the leach heap and the leach solution ponds.

When the gold content of the carbon is sufficient for stripping, the loaded carbon is moved to the carbon processing plant. The carbon is pumped to an acid wash tank where the loaded carbon is treated with a 5% solution of hydrochloric acid (HCl) to remove any mineral scale build-up (Figure 3.5-2). Acid soluble metals are also washed from the carbon in this step. The acid wash solution is neutralized in the acid wash tank by reaction with the natural carbonate minerals on the carbon. The metals that were dissolved from the carbon are precipitated as hydroxide sludges within the tank. This dilute sludge is rinsed from the carbon, passed over a fine carbon screen, and pumped to the chemical waste sump. From

the chemical waste sump, the sludge is pumped to the active barren pond where the sludge is mixed and pumped to the heap. If the acid is not adequately neutralized in the acid wash tank, washed carbon in the tank is treated with a NaOH solution to elevate the pH prior to pumping the washed carbon to the carbon strip tanks.

3.5.2 Carbon Stripping

The washed carbon is stripped of its gold with a solution of 1% NaOH at atmospheric pressure and a temperature of 190°F. The stripping is conducted in 2 banks of 2 closed, strip tanks, each bank connected in closed circuit with a strip solution tank, strip solution heater and electrowinning cell Figure 3.5-2. Approximately 20 GPM of strip solution is circulated for 72 hours to strip each batch of carbon.

3.5.3 Electrowinning

Gold is precipitated from the heated strip solutions onto steel wool cathodes in a process called electrowinning (Figure 3.5-2).

3.5.4 Carbon Regeneration

Stripped carbon is pumped from the carbon strip tanks back to the carbon columns (Figure 3.5-2). Continued reuse of the carbon results in a degradation of its adsorption quality so the carbon is occasionally reactivated (Figure 3.5-3). The carbon is first washed with water to remove any cyanide and then reactivated in a 1,500,000-BTU/HR, propane-fired kiln by heating to a temperature of 1200°F in an oxygen deficient atmosphere. The reactivated carbon is then quenched in a tank of water and pumped back to the carbon adsorption columns.

3.5.5 Gold Refining

The gold refining process is depicted on Figure 3.5-3. Cathodes, consisting of steel wool with plated gold, are removed from the electrowinning cells about every third day. After being air dried, the cathodes are placed in an electrically heated mercury retort to drive off any contained mercury. The mercury fumes are drawn off by a vacuum pump into a condenser where the mercury is collected for sale. The vacuum pump exhausts to the outside and does not have mercury carry-over. The cathodes are then mixed with soda ash, silica and borax flux and melted in an electric induction furnace to form a gold dore.

3.6 Ancillary Facilities

Ancillary or support facilities for the Barneys Canyon Project consist of an analytical laboratory, a truck shop and warehouse, explosives storage, fuel storage facilities, parking areas, the sulfide flotation plant, and an administration building. The locations of most of these facilities are shown on Plate III-A and Figure 3.3-2. The total laboratory facility includes a sample preparation room with drying and crushing equipment, wet chemistry laboratory, fire-assay laboratory, a metallurgical testing laboratory, and an atomic adsorption analytical room. The truck shop is used to service and maintain all mining equipment. The warehouse is used for storage of parts and equipment for the shop. The fuel storage facilities are sited as appropriate for efficient operations. Fuel spill control measures including safety berms are

installed at the fuel storage site. A Spill Prevention Control and Countermeasures (SPCC) Plan has been prepared and implemented as required by Federal law. The administration building houses offices for management personnel. Parking lots for employees are located at the administration building. Parking for company-owned equipment and man-carrying vehicles are provided adjacent to the truck shop, process building and administration building.

~~Ancillary facilities required for the expansion will be the infrastructure associated with the sulfide flotation plant (Figure 3.3-2).~~

3.7 Waste Disposal

Waste materials generated by the activities at the Barneys Canyon project consist of mine oxide waste rock, sulfide-bearing waste rock, spent ore on the leach pads, and trash. Mine Oxide waste rock is disposed in the waste rock dumps, as described in Section 3.2. Sulfide-bearing waste rock from the Melco Pit is placed in either the Melco Sulfide Repository or the NBCS Sulfide Repository. Spent ore will be reclaimed in place. Trash is hauled to a nearby, permitted municipal landfill. Waste solutions from the labs and process buildings are handled in the process system in accordance with DWQ permits.

Waste rock dumps are created by end-dumping material from haul trucks. Track type dozers push waste rock over the crest of the dump. The dumps are constructed with top surfaces sloping gently back toward the natural hillsides for the purpose of drainage control. During mining, the dump outslopes will have a slope angle of approximately 37 degrees.

Waste material from the North BC South and South BC South deposits will consist of calcareous sandstone, clay altered sandstone, and orthoquartzite. Similar material was is mined from the Melco deposit. ~~and has formed very stable waste rock dumps in terrain steeper than the site of the proposed BC South waste rock dump.~~

East Barneys deposit contains approximately 500,000 tons of Quarternary alluvium and 500,000 tons of sandstone, quartzite and limestone waste rocks. These rocks are also similar to materials currently being that were mined in the North Barneys and South Barneys Pits. ~~Waste rock from all of the pits has formed very stable dumps.~~

Dump slope stability analyses have been performed by Sergeant, Hauskins & Beckwith for the large Melco dump and the Barneys Canyon 6300 and 6500 mine dumps. Analyses were performed in those parts of the planned dumps where the most critical natural slope conditions were encountered. The planned dump configurations for this project, including placement of the dump material at the angle of repose (37 degrees) were used in the calculations. Stability analyses performed for the proposed dumps resulted in the following ranges of factors of safety (F.S.) under static conditions:

Barneys Canyon Dumps	F.S. = 1.05 to 1.33
Melco Dump	F.S. = 1.1 to 1.4

A safety factor of 1.0 or more indicates that a slope is stable; therefore, the Barneys Canyon and Melco dumps are predicted to be stable.

Sergeant, Hauskins & Beckwith also conducted dynamic stability analyses for the dumps.

These calculations indicate that "...permanent deformations under horizontal accelerations of 0.2 to 0.3 for the critical failure zones would be less than 2 feet." (Sergeant, Hauskins & Beckwith, 1988) Further details can be found in the dump stability analysis report which has been separately submitted.

In order to respond to the Division's rule regarding identification and handling of toxic materials, analyses of waste rock, ore, and leached ore were performed using one or more analytical techniques that are accepted means of determining toxicity of waste materials that are either naturally occurring or have been disposed in the natural environment. Waste rock was analyzed for total content of selected metals, weak-acid-soluble metals (EP toxicity test), and acid-base potential. Raw ore was analyzed for total metals. Spent leach material (leached ore) was subjected to total metals analyses and EP toxicity tests.

The EP toxicity test involves a 24-hour leach of solid material in a solution of acetic acid with a pH of 5.5. The ratio of leachate to sample is 20:1. The EP toxicity test was designed to simulate weakly acid conditions that can exist in landfill environments, and under which many metals may be dissolved and mobilized. The EP toxicity test was selected because it is an accepted U.S. EPA analytical protocol and is a worst case test for mine-related material. Initial mining of the Melco deposit will result in the disposal at the oxide mine dump of a small amount of pyritic waste rock in comparison to the total waste volume. However, since 1998 sulfide-bearing waste rock has been segregated into a designated sulfide repository. As described in Section 5.3.5 these repositories will be closed in a manner that minimizes the risk of surface and groundwater contamination from acid rock drainage. It is important to point out that mining wastes are currently exempted by Federal and State law from regulation under the laws and regulations that established the EP toxicity tests and for which EP toxicity analyses have regulatory impact.

The acid-base potential test was developed for evaluation of coal mine wastes. Each sample is analyzed for acid-generating potential and neutralization potential. Acid-generating potential is based on the total sulfur content of the sample. Neutralization potential is based principally upon the carbonate content of the sample; however, the effect of the ion-exchange capacity of clays is also taken into account. The results of acid-generating and neutralizations tests are calculated in tons of CaCO_3 per 1000 tons of material. In the case of acid potential, the result is expressed as a negative number equivalent to the tons of CaCO_3 required to neutralize the amount of acid generated. Neutralization potential is expressed as the tons of CaCO_3 -equivalent material per 1000 tons of waste. The results of each separate test are then added together. A positive result indicates that the sample is neutralizing, a negative number indicates that it is potentially acid generating. This result is used to determine the amount of neutralizing material (soil or overburden with neutralizing potential, or additives like agricultural lime) necessary to neutralize acid-generating waste.

Acid-base potential analyses were conducted for on a Barneys Canyon representative waste rock composite sample and two Melco representative composite waste rock samples that are representative of the upper portion of the ore body. Acid-base potential analyses for East Barneys consisted of were conducted on 18 waste rock samples from four waste rock types. The results from each rock type were averaged. The overall acid-base potential was calculated using a weighted average based on the volume percentage of each rock type within the East Barneys Pit. The calculated acid-base potential for these samples is as follows:

<u>Sample</u>	<u>pH</u>	<u>Acid-Base Potential</u>
Barneys Canyon (BC-85, composite)	8.9	+556 T/1000T
Melco (MC-25,5' to 255' composite)	8.6	-4 T/1000T
Melco (MC-25,375' to 570' composite)	6.3	-4 T/1000T
East Barneys	9.3	+12.5T/1000T

The full laboratory report is available in Appendix C-III. The analytical laboratory has determined that on average, the upper Melco samples are only slightly acid-forming, and therefore non-toxic. This is due to the relatively low pyrite content of the oxide ore and waste samples and the relatively small percentage of sulfide-bearing rock found in the upper part of the ore body. The samples selected for analysis were from drill holes containing both oxide and sulfide materials and were selected as representative of zones of mixed ore and waste that will be encountered during mining of the upper portions of the ore body. Most of the ore body contains only oxide ore and waste. The estimated total quantity of sulfide-bearing ore and waste in the original Melco pit was 625,000 tons; the sulfide fraction was estimated at approximately 300,000 tons. Total waste for Melco was 14,000,000 tons; therefore, the total sulfide-bearing material comprises only 4.5 percent of the total mine waste to be removed from the Melco pit. The mine dumps contain a like proportion of sulfidic waste. Therefore, the dumps will not generate acid solutions as a result of percolating rain water. Therefore, the dumps and this will greatly reduce the potential for dissolution and mobilization of metals, since these metals are insoluble at moderate to high pH's.

—The only significant sulfide mineral present in the ore and waste at Barneys Canyon is pyrite. Pyrite in quantities sufficient to generate significant acid will be readily identifiable by visible means. In addition, as part of gold assaying for mine ore grade control, the mine analytical laboratory determines not only gold content but also whether the ore and adjacent rocks are sulfide bearing or oxidized. The laboratory analysis is performed on closely spaced blast holes. The mine geologist or other person responsible for ore grade control in the pit is responsible for delineating and marking the pyritic waste rock in the pit throughout the life of the mine. During overburden removal, pyrite-bearing waste is identified both from the blast hole analytical results and by visual means, marked with flags and loaded in separate trucks for haulage to the waste rock dump where it is dumped such that non-sulfidic waste can be blended with it.

The lower portion of the Melco ore body contains large, discrete identified zones of sulfide mineralization as shown on Cross-Sections A-I-3-5 which are included in Appendix A-I, the Confidential Appendix. This sulfide-bearing rock will generate acid rock drainage under surface weathering condition. Some of the sulfide-bearing material occurs in isolated and irregular pods within the middle and upper parts of the ore body. The revised mining plan for the Melco deposit has resulted in a larger pit than had originally been contemplated. As a result, a discrete sulfide zone at the base of the ore body and near the pit bottom will be removed. The sulfide-bearing waste in the upper portions of the pit will ~~was~~, by virtue of its irregularity and relative rarity, be mixed with non-sulfidic waste during overburden removal

and dumping; therefore, no significant concentrations of sulfide waste will be deposited in the oxide dumps from these zones. The sulfide-bearing rock at the base of the ore body, though containing gold mineralization, does not lend itself to heap leaching and will not be mined with oxide ore. It was originally Kennecott's intention to mine the ore fraction of this material and haul it to its Magna smelter where, because of its high silica content, it could be used as flux and the contained gold recovered. It was determined that this sulfide could not be used as a flux but the ore grade material was stockpiled for treatment to recover the gold and remove the contained sulfide from the waste rock dumps. A sulfide flotation plant has been designed to remove most of the sulfur from the sulfide ore that has been stockpiled on site and the additional sulfide ore which will be liberated during mining. Engineering work and permitting are actively being pursued to treat this material which otherwise would have been placed in the waste dumps. However, because of the risk of acid generation, the large amounts of sulfide-bearing waste rock from the base of the Melco Pit can not be placed in the oxide dumps. In accordance with the State Division of Water Quality Waste Rock Management Plan, the sulfide-bearing rock is being identified according to geochemical and visual techniques, and is being placed in designated repositories. The sulfide-bearing ore from the lower pit is being milled and processed for gold recovery. Most of the pyrite is removed from the sulfide-bearing ore during the floatation process so the tailings are unlikely to acidify after they are placed on the heap leach pads.

The results of the total metals analyses and EP toxicity tests for the ore and waste are presented in Tables 3.7-1 and 3.7-2, respectively.

Total metal contents of various ore and waste samples are elevated above normal background as the results of as a result of the natural hydrothermal processes that formed the gold ore bodies.

The results of the EP toxicity analyses on unleached and leached ore are compared to appropriate U.S. EPA limits in Table 3.7-1. As this table demonstrates, none of the samples exceed or even approach the limits for EP toxicity set by the EPA. Hence, ore stockpiles and spent leach materials in the heaps are not anticipated to provide a source of soluble metals to the environment.

The results of EP toxicity analyses on Barneys Canyon and Melco waste rock, along with EPA EP toxicity limits are presented in Table 3.7-2. As in the case of the ore samples, the results of these analyses indicate no quantities of soluble metals in excess of the EPA standards for the EP toxicity procedure. In addition, since, as the acid-base potential analyses indicate, the waste rock dumps will not substantially lower the pH of the water percolating through them, the pH 5.5 conditions simulated in the EP toxicity test should not be approached at the site. Therefore, even the levels of metals reported out of the EP toxicity tests should not be reached in waters percolating through the mine dumps.

—The current mining plan for Melco estimates that a total of 29,000,000 tons of waste rock, including that excavated in the first phase of mining, will be generated. Of this quantity, approximately 1,100,000 tons of the waste will be sulfide-bearing or sulfidic waste rock. This represents approximately 4.0 percent of the total waste rock quantity. Sulfide waste generated by the expanded Melco operations will be blended with oxide waste rock during ordinary waste disposal operations to ensure adequate dispersal of sulfide material within the oxide waste and avoid encapsulation of significant concentrations of sulfide waste rock in the dumps. If necessary, non-sulfidic waste rock will be stockpiled for use as cover material for

~~the sulfidic material. A minimum three foot depth of non-sulfidic waste will be used to cover the sulfidic material.~~

The North BC South deposit contains no visible sulfide-bearing material. The results for analyses for acid-generation and neutralization potential for samples of waste rock and pit wall rock material from the North BC South deposit are summarized in Table 3.7-3. Copies of laboratory analytical reports from which this table was derived may be found in Appendix C. The non-weighted average acid-base potentials are 58.1 tons CaCO₃/1000 tons and 287.1 tons CaCO₃/1000 tons, respectively, for the waste rock and wall rock. These data indicate that the North BC South waste rock and wall rock are not acid-generating.

The South BC South deposit contained small amounts of visible sulfide and carbon in discontinuous pods. The only sulfide species identified was pyrite. This material represents one tenth of one percent (0.1 %) of all South BC South waste material. This is an order of magnitude less sulfide than is present at the Melco deposit. Based on the nature of the visible sulfide occurrence in the deposit and the pit design, the sulfide-bearing waste rock will be ~~was~~ blended with and covered by oxide waste rock during ordinary waste disposal.

Table 3.7-1 Results of Total Metals and EP Toxicity Analyses For Barneys Canyon Project

Ore

Concentrations (in ppm)

Sample Type and

Designation	As	Sb	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Te	Tl	Zn
Untreated Ore (Total) Barney															
(BC-131)	4300	<10	869	<0.5	4	33	45	36	1.0	23	16	17	9	90	103
Melco															
(MC-36)	3800	<10	3120	0.5	1	12	37	10	1.7	8	8	4	57	180	29
Melco															
(MC-38)	700	<10	2550	<0.5	1	11	36	15	1.0	41	7	17	39	50	43
Mean	2390	<10	2180	<0.5	2	19	39	20	1.2	29	10	13	38	107	58
Designation	As	Sb	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Te	Tl	Zn
Leached Ore (Total)Barneys															
(BC-131)	1300	2	1020	<0.2	2	35	52	56	NA	29	0.9	1.4	1.1	80	165
Melco															
(MC-36)	3900	10	3500	<0.2	<0.5	16	24	27	NA	14	2.3	0.3	5.6	190	29
Barneys/Melco															

Composite	50	2	475	0.2	1	54	47	56	NA	28	0.6	1.4	0.8	76	156
Mean	1750	5	1670			35	41	46		24	1.3	1.0	2.5	115	117

Leached Ore (EP Toxicity)

Designation	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
Barneys								
(BC-131)	0.1	0.13	NA	<0.01	<0.01	0.0001	<0.01	<0.01
Melco								
(MC-36)	0.013	1.5	<0.01	<0.005	<0.005	0.0023	<0.004	<0.01
Barneys/Melco								
Composite	0.004	2.4	0.03	0.03	<0.005	0.0040	<0.0040	<0.01
Mean	0.04	1.3				0.0021		
EP Toxicity								
Limits (EPA)	5.0	100.0	1.0	5.0	5.0	0.2	1.0	5.0

The results of analyses for acid-generation and neutralization potential for samples of waste rock and pit wall rock material from the South BC South deposit are summarized in Table 3.7-4. Copies of laboratory analytical reports from which this table was derived may be found in Appendix C. The results of analysis of the four wall rock samples indicate that pit wall rocks have a mean net neutralizing potential of 19.9 tons of CaCO_3 /1000 tons and will not be acid-generating. Waste rock classified as non-sulfide, due to the absence of visible sulfide minerals, comprises approximately 99.9 percent of the waste material, approximately 1,864,000 tons. This waste rock has a mean net neutralizing potential of 1.35 tons of CaCO_3 /1000 tons. The sulfide waste rock comprises an estimated 1,800 tons of material and is represented by one sample, SS-1, which has a mean net acid-generating potential of 278 tons of CaCO_3 /1000 tons. An acid base accounting of all the waste samples indicates that there is a net acid consuming capacity with the ratio of neutralizing potential: acid generating potential for all samples being 2.3:1

The small amount of sulfide-bearing waste rock ~~can~~ could be readily identified visually and ~~was~~ will be placed in the BC South waste rock dump such that it ~~could~~ will be covered by the non-acid-generating, clayey waste rock. As a part of the mine waste dump management plan submitted to the Utah Division of Water Quality, it has been determined that all dumps will be shaped to promote runoff of precipitation and minimize deep infiltration of water to the dumps. ~~No dumps will be allowed to impound water or to collect water in surface ponds which may enhance infiltration.~~

~~The expanded mining plan for Melco estimates that a total of 121.4 million tons of waste rock, including all waste mined to date, will be excavated and placed in waste dumps. Of this quantity, approximately 8.2 million tons or 6.8 percent of the waste will be sulfide-bearing or sulfidic waste rock. The sulfide-bearing waste generated by the Melco mining operations will be handled in accordance with the existing Utah Division of Water Quality ground water discharge permit.~~

Table 3.7-2 Results of Total Metals and EP Toxicity Analyses For Barneys Canyon Project Waste Rock Samples (in ppm)

Sample Type and Designation	As	Sb	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Te	Tl	Zn
Total Metals															
Barneys															
(BC-85)	200	<10	338	<0.5	5	80	31	185	0.5	42	<4	18	<5	60	129
Melco															
(MC-25,5'-95')	300	<10	650	<0.5	1	7	21	131	0.4	10	<4	4	<5	10	47
(MC-25,375')	2900	<10	730	<0.5	1	7	21	68	0.4	33	<4	3	8	120	105
Mean	1130	<10	573	<0.5	2	31	24	128	0.4	28	<4	8		60	94
EP Toxicity															
Designation	As	Ba	Cd	Cr		Pb		Hg		Se		Ag			
Barneys															
(BC-85)	0.11	0.4	<0.05	<0.05		<0.05		0.0001		0.08		<0.05			
Melco															
(MC-25,5'-95')	0.07	1.3	<0.05	<0.05		<0.05		0.0001		<0.05		<0.05			
(MC-25 375')	1.86	0.1	<0.05	<0.05		<0.05		0.0023		<0.05		<0.05			
Mean	0.68	0.6	<0.5	<0.5		<0.5		0.0008		<0.5		<0.5			
EP Toxicity															
Limits (EPA)	5.0	100.0	1.0	5.0		5.0		0.2		1.0		5.0			

Table 3.7-3 Summary of North BC South Waste and Wall Rock Acid Generation Potential Analysis

Sample No. (BCM)	% Sulphur	AGP as CaCO ₃	ANP as CaCO ₃	Net ABP as CaCO ₃
Waste Rock				
NW - 1	0.03	-0.9	2.1	1.2
NW - 2	0.02	-0.8	2.3	1.7
NW - 3	<0.01	<0.3	441	440
NW - 4	<0.01	<0.3	78.5	78
NW - 5	<0.01	<0.3	8.1	7.8

NW - 6	0.01	-0.3	9.9	9.6
NW - 7	0.02	-0.6	6.6	6.0
NW - 8	0.01	-0.3	24.6	24.3
NW - 9	<0.01	<0.3	8.0	7.7
NW - 10	<0.01	<0.3	5.3	5.0
Mean	0.01	-0.4	58	58

Wall Rock

NP - 1	0.02	-0.6	35.8	35.8
NP - 2	0.11	-3.4	4.7	1.3
NP - 3	0.03	-0.9	63.3	62
NP - 4	<0.01	<0.3	28.4	28
NP - 5	<0.01	<0.3	552	551
NP - 6	<0.01	<0.3	981	980
NP - 7	<0.01	<0.3	<0.1	*
NP - 8	<0.01	<0.3	14.5	14
NP - 9	<0.01	<0.3	913	912
Mean	0.02	-0.6	288	287

* All values less than detection limit

** AGP, ANP, ABP units expressed in tons of CaCO₃ per 1,000 tons of material

Table 3.7-4 Summary of South BC South Waste and Wall Rock Acid Generation Potential Analysis

Sample No.	% Sulphur	AGP as CaCO ₃	ANP as CaCO ₃	Net ABP As CaCO ₃
Waste Rock				
SW - 2	0.79	-24.7	3.9	-20.8
SW - 3	0.08	-2.5	18.8	16.3
SW - 4	0.13	-4.1	0.8	-3.8
SW - 5	0.06	-1.9	6.4	4.5
SW - 6	0.08	-2.5	2.5	0
SW - 7	0.09	-2.8	3.0	-0.2
SW - 8	0.28	-8.8	1.3	-7.5
SW - 9	<0.01	<0.3	15.7	15.4
SW - 10	0.32	-10.0	<0.1	-10.0
SW - 11	<0.01	<0.3	8.0	7.7
SW - 12	0.09	-2.8	<0.1	-2.8
SW - 13	0.41	-12.8	5.2	-7.6
SW - 14	0.38	-11.9	<0.1	-11.9

SW - 15	<0.01	< 0.3	40.4	
SW - 16	0.23	- 7.2	0.1	- 7.1
SW - 17	0.03	- 0.9	5.6	4.7
SW - 18	<0.01	< 0.3	26.3	26.0
SW - 19	0.09	- 2.8	8.1	5.4
SW - 20	0.10	- 3.1	<0.1	- 3.0
SW - 21	0.45	-14.1	4.1	-10.0
SW - 22	<0.01	< 0.3	<0.1	0.0
SW - 23	0.06	- 1.9	2.3	0.4
SW - 24	0.05	- 1.6	<0.1	- 1.6
SW - 25	0.07	- 2.2	0.5	- 1.7
Mean	0.16	-5	6.4	1.4

Sulfide Waste Rock

SS - 1	8.75	-273	<0.1	-273
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Wall Rock

SP - 1	<0.01	< 0.3	<0.1	0
SP - 5	1.01	-31.6	36.0	4.4
SP - 6	0.04	- 1.3	38.9	37
SP - 7	0.01	- 0.3	38.9	38
Mean	0.27	1.96	61	23
				-39

*AGP, ANP, ABP units expressed in tons of CaCO₃ per 1,000 tons of material

3.8 Production Schedule

Waste rock removal began in the Barneys Canyon pit in the first quarter of 1989 and in the Melco pit in late 1989. Currently only the Melco pit is still active and mining there will end in late 2001. Barneys Canyon and Melco pits were mined concurrently in 1989 and 1990, by which time the first phase of Melco was mined out. Mining will continue in the Barneys Canyon pit through 1995. It is anticipated that active leaching and gold recovery from the leach pads will continue for several years after the mining and other ore processing facilities have been closed.

In order to mine the North BC South, the South BC south and the Melco ore bodies in a timely manner, Kennecott will begin pre-stripping the South BC South deposit during the fourth quarter of 1992. This schedule will allow the ore body to be placed in production during the first quarter, 1993. Pre-stripping of the North BC South pit could begin during the second quarter of 1993 with ore production beginning during the first quarter, 1994. The second phase of pre-stripping at Melco will begin during the first quarter, 1993, with ore production commencing during the first quarter, 1994. Barneys Canyon and Melco pits will be mined concurrently in 1994 and 1995 until the Barneys Canyon ore deposit is exhausted. Mining will continue at Melco alone from 1995.

The Barneys Canyon mine will operate two 12-hour shifts per day, 7 days per week, 52 weeks per year. Because of limitations imposed by severe weather conditions, Melco operations may be curtailed during the worst winter months; however, if conditions permit, mining will proceed 24 hours per day and 52 weeks per year. The crushing plant and process plant are scheduled to operate 24 hours per day and up to 365 days per year. The laboratory and truck shop are operated year-round.

in support of both and mining and process operations.

~~Construction of the Melco north dumps is scheduled to begin in the third quarter of 1994 with prestripping of the Melco D phase planned to begin in early 1995. Mining of the North BC South pit is scheduled to begin in the 4th quarter of 1994.~~

~~The East Barneys Deposit is scheduled to be mined in 1997. Topsoil stripping and removal of alluvium will commence as weather allows early in the year. Mining is expected to continue through the third quarter 1997.~~

3.9 Topsoil Management

Available topsoil materials at the Barneys Canyon mining site were stripped with dozers and scrapers then placed in storage piles on sites protected from excessive surface runoff. Planned Topsoil stockpile sites are shown on Plate III-A. The topsoil portion of the soil profile, consisting, on average, of the upper 12 inches, was salvaged. In areas underlain by Copperton soils no more than the upper 12 inches of topsoil was salvaged. The Soil Conservation Service (SCS) has determined that these soils are less than ideal for use as topsoil. Facility sites having Copperton soils include all the leach pads, the solution ponds, process building, substation, administration building, crushing and screening area, the eastern 3.8 acres of the shop building area, and the eastern 2.6 acres of the ore stockpile area. All other facilities are covered with Harkers-Dry Creek association, Dry Creek-Copperton association or Bradshaw-Agassiz association soils which the SCS recognizes as suitable for use as topsoil. For these soil types, borrow depths exceeded 12 inches where possible to meet topsoil volume needs.

Recoverable soil volumes for each component of the project are summarized in Table 3.9-1. In the event that areas currently ~~areas~~ identified for topsoil salvage ~~that were~~ are found during recovery operations to lack the 12 inches of topsoil necessary, the balance of the soil necessary to carry out the topsoil redistribution plan described in Section 5.4 ~~will be~~ ~~was~~ maintained by borrowing additional soils from other areas having greater than 12 inches of soil.

In the Melco Phase A area, total available topsoil exceeded the anticipated topsoil demand for reclamation by approximately 28,000 cubic yards, as described in Table 3.9-1 and section 5.4. Because of the steep terrain and resultant difficulties in removing and transporting the material, only a sufficient volume of topsoil to accomplish the planned reclamation work, was recovered and stockpiled from the pit and dump sites.

Recoverable soil volumes for each component of the ~~two new proposed~~ ~~South Barneys Canyon~~ pits and the Melco expansion are summarized in Table 3.9-2. Kennecott ~~prepares to salvage~~ topsoil from all areas where salvaging operations can ~~could~~ be safely conducted. Areas with very steep slopes, principally the sites of the Melco 7200 and 7300 waste dumps, ~~are~~ ~~were~~ not generally suitable for the safe removal of topsoil.

The potential for loss of topsoil during salvage operations due to equipment inefficiencies on relatively steep slopes and the reduction of salvageable topsoil in some wooded areas caused by large tree roots has been considered. ~~It is assumed that~~ This loss ~~will be~~ ~~is~~ balanced by ordinary swelling following salvaging and the added volume that will be created by mixing vegetation with the

soil during salvaging and stockpiling operations. In addition, although it has been assumed for the purposes of estimation that only one foot of soil would be ~~has been~~ available for salvage, it is probable that soil will be ~~soil has been~~ stripped to a greater depth in many areas.

The topsoil recovery plan will include mixing the existing vegetation into the soils which will provide additional organic matter to the salvaged soils. The topsoil storage piles will be ~~are~~ protected from wind erosion and slope drainage by seeding with 6 lbs per acre of annual rye to protect the surface with a quick growing vegetative cover. In addition, Kennecott will ~~apply~~ applies the permanent reclamation seed mix to those topsoil stockpiles or parts of topsoil stockpiles which will not receive future contributions of topsoil. Stockpile surfaces that will receive additional topsoil as ~~part of~~ ongoing mine expansion will be vegetated with the interim seed mix.

Kennecott will salvage topsoil from areas where salvaging operations can be safely conducted and up to the quantity of topsoil required to achieve the reclamation plan. This topsoil will ~~is~~ predominately be salvaged from the main drainage of Barneys Canyon where access is easy and the soil depth the greatest.

Table 3.9-1 Topsoil Yields

Average				
Salvage Site	Salvageable Soil Types	Volume		(Cu. Yds.)
		Depth	Acreage	
Barneys Canyon Pit	Harker-Dry Creek	12"	52.3	84,377
Barneys Canyon Pit	Rocky Variant	0"	4.1	0
Barneys Canyon Dumps	Harker-Dry Creek	12"	125.6	202,635
Melco Pit	Bradshaw-Agassis	12"	35.2	56,789(1)
Melco Dumps	Bradshaw-Agassis	12"	42.4	68,405(1)
Admin. Bldg., Process/Lab & Solution Ponds, Gravel/Clay Pits 1 & 2	Dry Creek-Copperton	12"	24.7	39,849
Clay Pits 2 & Alternate	Harker-Dry Creek	12"	2.0	3,227
Potable Water Storage, Ore Stockpile	Harker-Dry Creek	12"	6.9	11,132
East Portion Crushing/Screening and Shop	Harker-Dry Creek	12"	10.7	17,263
West Portion Crushing/Screening and Shop	Dry Creek-Copperton	12"	8.8	14,197
Leach Pads BC-1,2,3; M-1,2; Future Leach Pad and North & South Portions of BC-4	Dry Creek-Copperton	12"	215.6	347,835

Remaining Portion of Leach Pad BC-4	Copperton	12"	12.5	20,167
Substation	Dry Creek-Copperton	12"	<u>0.4</u>	<u>645</u>
Total			541.2	866,521(1)

(1) Actual topsoil borrowed in the Melco area is estimated to be 97,363 cubic yards; therefore, a total of 100,000 cubic yards of material, sufficient to cover the surfaces to be topsoiled, as described in Section 5.4, will be recovered and stockpiled.

Table 3.9-2 Topsoil Yields

Salvage Site	Salvageable Soil Types	Average Depth	Acreage	Volume (Cu. Yds.)
NBCS Pit	Fitzgerald	18"	0.1	360
	Gappmayer	24"	6.3	20,190
SBCS Pit	Fitzgerald	18"	4.7	11,360
	Gappmayer	24"	5.2	16,720
	Rock Outcrop	0"	1.2	0
	Wallburg	15"	9.0	18,090
BCS Waste Dump	Gappmayer	24"	4.4	14,170
	Wallsburg	15"	5.6	11,330
Relocated Melco Haul Road	Wallsburg	15"	4.6	9,230
Melco Pit (Expansion)	Bradshaw-Agassiz	12"	5.5	8,910
	Fitzgerald	18"	17.8	43,170
	Rock Outcrop	0"	<u>5.2</u>	<u>0</u>
Subtotal			69.5	153,530
Topsoil Stockpile H	N/A	N/A	N/A	*20,000
Topsoil Stockpile I	N/A	N/A	N/A	*117,110
Total			69.6	290,640

* Topsoil currently in stockpiles at Melco

3.10 Runoff and Sediment Control

The BC South, Barneys, East Barneys and Melco pits and waste dumps occur in drainage basins that will be have been extensively disturbed by current and proposed past operations. Current operations at the Melco pit are still impacting the Dry Fork and upper Barneys drainage. The extent of the proposed disturbances, drainage basin boundaries, the surface runoff flow directions, and

operational erosion and sediment control devices are shown on Plate II-B. Both the Melco and BC South areas occur in small watersheds near watershed divides. The Melco pit, roads, and waste dumps will occupy essentially the entire watershed area of the upper right fork of Dry Fork, as Plate II-B shows. The BC South watershed area will contain a small amount of undisturbed watershed above the South BC South pit and the BC South waste rock dump (Plate II-B). The runoff from this area will flow to the BC South pits and around the BC South waste rock dump. Most runoff from this small area of undisturbed watershed cannot be diverted from the down-gradient disturbed areas; therefore, it is not possible to separate the runoff from this disturbed area from the runoff that will be generated in the down gradient disturbed area. Since most runoff from the BC South area will be collected and prevented from being released outside the small disturbed watershed, the inability to separate runoff from disturbed and undisturbed areas will have no adverse impact on the local surface water hydrology.

The Melco north dumps are located in Barneys Canyon and will affect approximately 7000 feet of the intermittent ~~portion of~~ and perennial Barneys Creek. Many of the slopes in the watershed area are cross-cut by the KTVX access and exploration roads. These existing roads are intersecting the up slope runoff and channeling the water laterally away from much of the planned dumping area. Where necessary, the existing exploration roads will be upgraded to double as diversionary ditches to keep any runoff water from entering the disturbance areas. The waste dumps will be ~~are being~~ constructed in stages ~~over the next several years~~ starting in the southern fork of the drainage and progressing downstream to the east. Any runoff water will be ~~is~~ handled in accordance with the existing DWQ ground water discharge permit. The operational runoff and sediment control plan can be seen on Plate II-C.

The East Barneys pit lies in the bottom of the Barneys Canyon drainage. ~~Existing~~ During active operation, sediment controls (settling basin and diversion ditch) ~~are were~~ located about 500 feet upstream from the pit. A diversion berm that will provide some containment capacity and sediment control will be ~~was~~ constructed at the upstream boundary of the pit to divert surface water flow from the existing drainage to the pit area. At completion of mining, this containment will be ~~was~~ breached, allowing surface runoff water to flow into the pit. Erosion of the west pit walls will be ~~was~~ minimized by rip-rapping the west border of the pit where the drainage runs will run.

~~The operational diversion ditch will begin in the bottom of the Barneys Canyon channel uphill (west) from the East Barneys pit and lead around the north end of the pit. Where this diversion ditch begins, an earth berm will be constructed by excavating a hole approximately 4 feet deep in the bottom of the natural channel uphill from the desired berm location and pushing the excavated alluvial materials into a berm at least 4 feet high, with a 3-foot wide top, 2h:1v side slopes and a crest length sufficient to completely dam the Barneys Canyon channel just below the entrance to the diversion ditch. This berm will be compacted with the bulldozer during construction. If the alluvial materials used to construct the berm are devoid of cobbles or larger rocks to provide erosion protection, the uphill face of the berm should be covered with at least 6 inches of riprap have a D₅₀ of at least 3 inches. Alternatively, the entire berm could be constructed of oxide mine overburden that was rocky enough to withstand erosion. The Appendix, DII (b), conceptually shows the design of this berm which will need to be field fit during construction.~~

The East Barneys pit will remain in its as-built condition within the bottom of the Barneys Canyon

drainage. The operational drainage diversion used to divert Barneys Canyon around the pit during operations will be ~~was~~ backfilled and reclaimed. The diversion berm constructed to block the natural Barneys Canyon Channel and divert it into the temporary ditch will ~~also be~~ ~~was also~~ removed from the natural channel to open the natural channel to a free-flowing condition. A permanent reclamation channel will be ~~has been~~ constructed to drop the Barneys Canyon channel into the East Barneys pit in a stable fashion.

The permanent reclamation channel will begin at the contact between alluvium and rock within the pit and be graded at an overall 33% grade or less uphill to the natural Barneys Canyon channel elevation (see Appendix DII (c)). The bottom of this channel excavation will be ~~is~~ approximately 8 feet wide and the sides slopes will be approximately 4h:1v or flatter. The design flow for this permanent channel is 195 cfs which is the 100-year, 24-hour peak flow calculated by JBR for the Barneys Canyon watershed. This calculation used the same watershed configuration and computer model last used in the November, 1993 NOI except that the average weighted Curve Number for the watershed was increased from 48 to 57 to take into account the approximately 300 acres of reclaimed overburden dumps that will exist in Barneys Canyon when the Melco wasterock dumps are completed.

The flow conditions in the permanent channel were calculated using the SECAD 3 computer program (Appendix DII(c)). The calculated flow velocity of 13 fps will require the use of a 4-foot thick blanket of riprap, having a D_{50} of 15 inches over the bottom of the channel and extending at least 2 feet up the channel sides. This same riprap will extend up the natural Barneys Canyon channel for approximately 50 feet uphill of the start of the constructed channel to protect this transition section. There will be ~~is~~ no need for a similar riprap blanket at the outlet of the channel where it discharges onto the rock surface of the East Barneys pit.

The East Barneys pit will contain the water draining down the Barneys Canyon channel. The pit will ~~not be~~ ~~is not~~ self draining and will hold water within the pit bottom up to the 6080 foot elevation before any additional water will drain over the east end of the pit and down the natural Barneys Canyon channel. All the rock exposed in the East Barneys pit is expected to be oxide material with no sulfidic mineralization. Therefore, the water in the pit should not contact any acid generating material and should have no deleterious water quality impacts on local surface water or ground water quality. A small amount of water is ponded in the bottom of the pit year round, but it has never risen high enough to flow out of the pit. The water contained in the pit is expected to be ephemeral to intermittent in nature and will be available for seasonal use by wildlife as a water source. The local water table is below the bottom elevation of the pit so a perennial water impoundment is not expected to occur. Any overflow from the pit will flow down the natural Barneys Canyon channel.

3.10.1 Runoff Volumes Estimates

Runoff volumes and peak flows in and around the project area were calculated using the Soil Conservation Service (SCS) Curve Number technique, utilizing a computer program developed by Hawkins and Marshall (1980). Precipitation depths for the 10-year, 25-year and 100-year, 24-hour rainfall events were used in the calculations to determine the runoff peaks and volumes for each event. The precipitation depths were obtained from the National Oceanic and Atmospheric Administration Precipitation Frequency Atlas for Utah (1973). The precipitation depths for these events were found to be 2.7 inches, 3.0 inches, and 3.7 inches, respectively. Runoff peaks were

generated using the SCS Type II rainfall distribution which is typical for the western United States.

The curve numbers used in these calculations were based on local soil hydrologic characteristics and vegetation types. Soils were grouped according to infiltration characteristics, hydrologic soil group A having the highest infiltration rates and group D having the lowest infiltration rates. There are three main hydrologic soil groups in the project area. Soils of group C are found largely in the valley alluvium and colluvium beneath the Barneys Canyon project area. Soils of hydrologic group B are predominantly found in the higher elevations. Soil Group D represents the dumped waste material. The vegetation types are largely sage/grass community in the lower elevations and gambel oaks on the low elevation north facing slopes and in the higher elevations. Based on this and other information obtained over one year of work at the site, the base curve numbers have been revised to better reflect actual runoff conditions at the project site.

<u>Vegetation type</u>	<u>Soil Group B</u>	<u>Soil Group C</u>	<u>Soil Group D</u>
Oak/Aspen/Woods	CN= 35	CN= 64	CN= 79
Sagebrush	CN= 48	CN= 65	
North Slope	CN= 58		CN= 78

Source: U.S. Department Interior, Bureau of Reclamation (1977)

Curve numbers were weighted according to the area covered by each vegetation and soil type. A curve number of 89 was used for calculating runoff volumes and peaks from the compacted waste dump surfaces and surrounding disturbed areas at Melco. A high curve number was intentionally selected to provide a conservative estimate of runoff from waste dumps; the actual runoff would be expected to be less than that predicted. The assumptions used in these calculations may be found in Table 3.10-1 below.

The drainage basins and watershed areas used in the runoff peak and volume calculations are outlined on Plate V-A and II-B. Calculations were made using the undisturbed watershed areas so that all designs would be conservative once the facilities are built. All operational culvert and ditches have been designed to transfer runoff from the 10-year, 24-hour runoff event. The largest watershed to be disturbed by the operation is Barneys Canyon with an area of 1430 acres. ~~The Barneys Canyon drainage will remain largely unaffected by the operations with the exception of the Melco pit access/haul road crossing. Six other drainages will be have been~~ significantly disturbed by the mining operations. The Barneys Canyon pit, adjacent waste dumps, leach pads, and process facilities will occupy large sections of drainages P, Q, S, and T. Drainage area R will remain largely undisturbed by the operations except for a small area to be occupied by the two northeastern-most leach pads. The BC South drainage area ~~will be has been~~ affected by the proposed pits and waste dump. The Melco pit and waste dumps will occupy a large portion of the right fork of Dry Creek.

After taking into account the planned locations of new proposed dumps, these drainage areas have been given the designations listed in Table 3.10-1.

The Melco north dumps will eventually occupy a large portion of the upper Barneys Canyon main drainage. Approximately 300 acres of the 1430 acre watershed will be disturbed during the mine life. This disturbance will occur at the rate of about 80 acres per year and is not expected to significantly affect the runoff volume estimate due to sediment and runoff control measures.

Table 3.10-1 Curve Numbers for Barneys Canyon Drainage Basins

<u>Drainage Basin ID</u>	<u>WS Area</u>	<u>Curve Number</u>	<u>Soil type</u>	<u>Vegetation</u>		<u>Runoff Depth (in)</u>		
				<u>% oak</u>	<u>% sage</u>	<u>10Yr</u>	<u>25Yr</u>	<u>100Yr</u>
M (impdmt)	56.5	65	C	45	55	0.38	0.51	0.86
N	118.0	48	B	40	60	0.03	0.06	0.18
O	45.2	48	B	100	00	0.03	0.06	0.18
P	332.0	65	C	30	70	0.38	0.51	0.86
Q	96.0	65	C	40	60	0.38	0.51	0.86
R	462.0	65	C	25	75	0.38	0.51	0.86
S	580.0	65	C	45	55	0.38	0.51	0.86
T	37.8	65	C	00	100	0.38	0.51	0.86
BCS*	126	56				0.14		0.45
M-a	231	89				1.63		2.54
M-b	16	89				1.63		2.54
M-c	7	89				1.63		2.54
Barneys Canyon	1430	48	B	75	25	0.03	0.06	0.18
<u>Waste Dumps</u>	<u>N/A</u>	<u>89.0</u>	<u>D</u>	<u>00</u>	<u>00</u>	<u>1.63</u>	<u>1.90</u>	<u>2.45</u>

*Curve number calculated assuming pits would have been pre-stripped, but not excavated.

3.10.2 Operational Runoff Control

The operational runoff control plan, depicted on Plate III-A, has been designed to take advantage of the existing impoundment capacity created by the B&G railroad grade fill structures. The B&G railroad grade runs along the eastern perimeter of the project site. The fill structures through drainage crossings will impound all runoff from the upland drainage basins including Barneys Creek (Plate III-A). Approximately 60 years ago when the railroad was constructed, culverts were placed in the stream channel at the bottom of the railroad fill to allow runoff water to flow through this embankment. Since that time, these culverts have become partially or completely filled with sediments rendering them ineffective and causing the embankment to act as an impounding structure. In 1985, each impoundment was fitted with a spillway culvert approximately 15 feet below the grade elevation in each drainage to permit impounded water to drain through the impoundment without the likelihood of overflow. The spillway culverts were designed to pass the 50-year flood event or larger and were placed high enough in the embankments to provide significant storage capacities below the spillways. All spillway culverts are 24 inches or greater in diameter to meet minimum design criteria by the Utah State Engineer. These spillway culverts are in place and the calculated capacity of each impoundment is based on the invert elevation of the these spillway culverts. Water is not routinely impounded behind these structures. A diagram illustrating the placement of these culverts may be found in Appendix D-I. The stage/capacity curves for all impoundments located in the project area may be found in Appendix D-I. The runoff volumes from the watersheds upgradient of these impoundments were calculated using undisturbed acreages. Using this technique, the runoff volumes calculated should be in excess of the actual runoff volumes after all facilities are constructed, because precipitation falling on active leach pads will be directed to the solution ponds and inactive, ore-covered pads will have substantial moisture retention capacity.

Most haul roads have been designed to allow water runoff from both road surfaces and the upgradient watersheds to move along or beneath them with minimal impacts from erosion (Plate III-A). The fill material from the landbridge haul roads southeast of waste dumps 6400 and 6500 created three temporary impoundments which were later filled with dump materials. Culverts were installed in the road fill materials that create these temporary impoundments. The roads are sloped away from the road fill slope so all precipitation water falling on the road surface will drain toward roadside ditches. Roadside ditches run the length of the haul roads through the project area and are placed along the roadside cut slope to collect all runoff from the watersheds upgradient before the water flows onto the road surface. The roadside ditches are triangular in shape and a minimum of 1.75 feet deep. The ditches have a 2h:1v sideslope from the road surface and 1h:1v from the cut slope. These ditches are placed at the same gradient as the road. Many of the haul roads are excavated into the bedrock adding stability to these ditches during high runoff events. All roadside ditches drain to corrugated metal pipe culverts to transfer the water below the road and into impoundments or natural stream channels below (Plate III-A).

Corrugated metal pipe culverts divert runoff water beneath the road at selected crossings. These culverts have been designed to pass runoff from the 10-year, 24-hour runoff event. The culverts are placed along the natural channel gradient to minimize erosion. Design specifications for these culverts may be found in Appendix D-II.

~~During operations, all waste dumps are constructed so that the dump surface slopes from the dump crest toward the natural hillside from which it projects to control runoff down the outslope of the dump.~~ Safety berms are placed around the top perimeter of the waste dumps as needed to prevent runoff flow from the dump crest down the dump face. The dumps are then sloped so that runoff drains toward one corner of the dump for removal to either a drainage channel or to an impoundment.

Runoff from the small drainage area upgradient of the Barneys Canyon pit waste rock dumps and from the adjacent waste rock dump surfaces has been diverted into Impoundment M located upgradient of the lower elevation haul road leading from the Barneys Canyon pit to the waste dump (Plate III-A). Runoff from the undisturbed watershed area upgradient of the haul roads drains onto the uppermost haul road and is diverted along a roadside ditch and through a culvert for containment in Impoundment M. Runoff from dump 6500 will also drain through a culvert for collection in Impoundment M. In addition, runoff from the waste dump 6400, adjacent to the Barneys Canyon pit, will drain into Impoundment M. The 100-year, 24-hour runoff volume from the three waste dumps and the upper watershed will be 10.3 acre-feet and will be easily contained within Impoundment M (Table 3.10-2). Current Utah DOGM regulations require that the impoundments must contain the 10-year, 24-hour runoff volume.

Before the waste dumps were built, the haul road to the truck shop created three impoundments in the area to later be occupied by the waste dumps. The impoundment occupied by dump 6400 had a capacity in excess of 80 acre-feet and received runoff from the 15 acre basin in which it occupied. This impoundment did not receive runoff from beyond its perimeter. The other two impoundments, designated Dump 6500 A for the next impoundment to the north and Dump 6500 B for the north impoundment, were used to contain runoff from the watershed above until the waste dumps were completed. These impoundments are not shown on Plate III-A. The capacity of Dump 6500 Impoundments A and B contained the full runoff volume from the 100-year, 24-hour runoff

event from the upland drainage basins.

The leach pads will occupy portions of drainage areas P, Q, R, and T (Plate III-A). Due to the closed leaching system, any precipitation falling on the active leach pad surfaces will run through the pad solution drainage systems before containment in the downgradient pregnant solution ponds. The leach solution systems will have the capacity to contain the 100-year, 24-hour runoff event from active pads in addition to the volume of water used in the leaching process. The ponds have been designed to overflow into one another before discharging thereby creating additional impoundment capacity above the 100-year, 24-hour runoff capacity design. Any solution pond overflow from the ponds is contained behind the B&G grade railroad impoundment.

The retention capacity of each of the railroad grade impoundments was calculated from topographic maps and known spillway culvert invert elevations. Based upon the elevation of spillway culvert inverts, the capacity of each of these impoundments and the calculated runoff volumes for the 10-year, 25-year, and 100-year, 24-hour runoff events draining into these impoundments from upland drainage basins are given in Table 3.12-2. As can be seen in Table 3.12-2, all impoundments on the property will contain runoff from the 100-year, 24-hour events with the exception of Impoundments R and P. However, Impoundment R will contain runoff from the calculated 25-year, 24-hour runoff event and the capacity of Impoundment P falls 0.3 acre-feet short of containing the calculated 100-year, 24-hour runoff volume from the undisturbed drainage basin. None of the railroad grade impoundments show signs of significant water impoundment.

Table 3.10-2 Barneys Canyon Project Impoundment Containment Volumes

<u>Impoundment/ Basin I. D.</u>	<u>Watershed Area (ac)</u>	<u>Runoff Volumes (Acre-feet)</u>			
		<u>Impoundment Capacity (AF)</u>	<u>10yr 24hr</u>	<u>25yr 24hr</u>	<u>100yr 24hr</u>
M	56.5	47.0	5.8	7.1	10.3*
P	332.0	23.5	10.5	14.1	23.8
Q	96.0	12.4	3.0	4.1	6.9
R	462.0	21.0	14.6	19.6	33.1
S	580.0	85.4	18.4	24.7	41.6
T	37.8	9.0	1.2	1.6	2.7
Barneys Canyon at B&G Grade	143.0	182.0	16.1	28.6	62.0
Melco Soil Dam	13.1	6.6	1.1	2.0	
Dump 6500 A	28.1	51.9	0.9	1.2	2.0
Dump 6500 B	30.2	13.2	1.0	1.3	2.2

Runoff volumes are based on the weighted curve numbers for each watershed.

* Runoff volumes cited for M include runoff from the adjacent waste dumps.

The placement of the Melco mine dumps will affect the natural surface water drainage characteristics of a tributary watershed of Dry Fork Canyon (Plates II-B and 96-1). Precipitation in the pit and upgradient runoff will be contained within the pit (Plate II-B). Water will not drain from the pit into the Dry Fork drainage. A soil dam was placed in the upland drainage area of the Dry Fork basin creating the temporary Melco sediment impoundment (Plate II-B). This dam currently has the capacity to hold 6.6 acre-feet of runoff volume. This is adequate to hold the 2.0 acre-feet of runoff for the 100-year, 24 hour precipitation event, which would not be collected in the Melco pit (Table 3.10-1). A capacity curve showing the storage capacity of this dam in relation to elevation is shown in Appendix B-II. Any water released from the Melco sediment impoundment will be contained downstream in a much larger impoundment that has been created by mine dumps placed across Dry Fork as part of Kennecott's Utah Copper operations.

The Melco pit haul roads will carry runoff water along a series of roadside triangular ditches to be routed around the mine dumps before release into either the existing Melco sediment impoundment, the Melco pit, or the impoundments created by the waste rock dumps, as discussed above (Plate II-B). Corrugated metal pipe (CMP) culverts will be placed in areas where drainage will cross the roads (Plate II-B). Culverts will be installed using the same procedures as for the existing culverts. (Culvert diameters are given on Plate II-B.) All ditches have been designed to carry the peak flow from the 10-year, 24-hour rainfall event.

The operational runoff control plan, depicted on Plate II-B, has been designed to take advantage of the existing structures, described previously. Except for the Melco pit area, the culverts have been installed as described.

Ditches were designed using a computer program developed by Hawkins and Marshall (1980). Culverts were designed using procedures outlined by the American Iron and Steel Institute (AISI, 1983). A Mannings constant of 0.03 was used in ditch calculations. This value was obtained from AISI (1983).

Most haul roads have been designed to allow water runoff from both the surfaces and the upgradient watersheds to move along or beneath them with minimal impact from erosion (Plate II-B).

Haul road ditches and culverts will provide the means of runoff control during the period that mining is in progress. In most areas the roads will be sloped away from the road fill slope so that all precipitation water falling on the road surface will drain toward roadside ditches. Runoff from the section of re-aligned Melco haul road located south of the North BC South pit will flow to the North BC South pit impoundment, as shown on Plate II-B. Roadside ditches will extend the length of most haul roads through the project area and will be placed along the inboard margins to collect runoff from the watersheds upgradient before the water flows onto the road surface. The roadside ditches will be triangular in cross section and a minimum of 2.0 feet deep. In most cases the ditches will drain to corrugated metal pipe culverts which will direct the water beneath the road and into impoundments or natural stream channels below (Plate II-B). In the vicinity of the Melco 7200 and 7300 waste rock dumps, runoff will flow directly from the road surface to impoundments created by these dumps or directly to the Melco open pit, as shown on Plate II-B. The surface of the 7300 dump will be sloped back from the outslope sufficiently to create sediment and runoff retention capacity on its surface. The 7200 dump surface will also be sloped away from the south outslope. Runoff will flow down the north slope of the dump to the haul road below and then into the Melco pit.

Erosion of the roadfill material from culvert outfall will be prevented by installation of erosion control mats which will extend from the outfall point, downslope to the undisturbed drainage below. The locations of these mats is shown on Plate II-B. These mats will be made of either commercially available erosion control matting or of used conveyor belt material. The former would be installed according to manufacturer's specifications and the latter would be installed using appropriate anchoring devices, as determined by Kennecott mine staff. These mats would extend from just above the culvert outfall points, across the road fill slope, and to the undisturbed natural hillside or channel below.

During operation, all waste dumps will be constructed so that dump surfaces slope away from the crest toward the adjacent natural hillside or upstream impoundments to control runoff down the outslope of the dump. Berms will be placed around the top perimeter of the waste dumps as needed to prevent runoff flow from the dump crest down the dump face. The dumps will also be sloped so that runoff drains toward one corner of the dump for removal to either a drainage channel or to an impoundment.

The existing impoundment created by the B&G grade crossing Barneys Canyon (Plate II-B) is located downstream from the BC South disturbances and will contain any runoff and sediment that may be released from the site (Table 3.10-1). A stage-capacity curve for the Barneys Canyon B&G grade impoundment is included in Appendix B. Emergency discharge culverts in these impoundments have resulted in retention capacities well in excess of the 10-year, 24-hour precipitation event, as described in Section 3.10-3. The Dry Fork impoundment that has been created by the waste rock dumps of Kennecott's Utah Copper Division will serve a similar function for the Melco area.

The existing runoff control plan has been modified so that runoff water is no longer diverted into the Melco or NBCS pits. Direct precipitation will, of course, continue to fall unimpeded into the pits. The Melco 7200 waste dump has been redesigned to drain away from instead of into the Melco pit. Control measures for the Melco north dumps will use a combination of existing measures (haul road ditches, dump surface sloping, B&G grade and explorations roads).

3.10.3 Operational Sediment Control

The nature and placement of the mine pits, waste dumps and leach pads will potentially increase the erosion and sedimentation rates in the project area. Much of the rock and alluvium exposed during mining will increase the potential for sediment movement both on the site and to locations off site. To control this process, a number of sediment control features are placed on site to inhibit the movement of sediment. These structures include detention basins to contain sediment, diversion channels to divert the flow of water around areas having a high potential for sediment movement, and silt fences placed below potentially erosive areas to control sediment movement into nearby channels. Hay bales are placed in areas recognized as having excessive sediment movement during operation for additional control of erosion.

The desilting pond, located immediately west of the solutions ponds, is designed to contain storm runoff from the 100-year, 24-hour event in the upland watershed. This design is based on DWQ approved criteria. The discharge from the pipe spillway serving the sediment control impoundment is collected in a bifurcated pipe that is connected to a 36-inch diameter CMP storm

drain. This pipe bypasses the solution pond area and discharges into an existing 48-inch diameter culvert which passes under the B&G grade east of the solution ponds. This storm drain will pass the flow from a 100-year, 6-hour precipitation event. The majority of the runoff from the small drainage area surrounding the solution ponds themselves is collected in a concrete sump just west of the ponds and is pumped into the desilting basin.

The abandoned B&G grade railroad embankment, located along the eastern edge of project site, creates a number of impoundments which will be used to eliminate sediment release from the site. These impoundments will also be used as emergency containment for solution pond overflow (Plate III-A). The designed 50-year event capacity emergency culverts, described above, provide the only discharge points from the impoundments. These sediment storage basins will be maintained as needed by periodic removal of the collected sediments to maintain the existing capacities of the impoundments. Stage capacity curves (Appendix D-I) for each of these impoundments have been produced to verify that the impoundments have adequate capacities to contain the 10-year, 24-hour runoff volumes from the upstream drainage areas. Since this railroad grade cuts across all of the drainages downgradient of the project site, any sediment not contained by upstream sediment control structures such as silt fences or hay bales would ultimately be contained within these impoundments.

Two forms of sediment control ~~will be~~ ~~are being~~ implemented to control sediment runoff from the waste dumps, the largest potential sources of sediment on the property (Plate III-A). Waste dump ~~surfaces will be sloped away from the dump margins~~ ~~edges are bermed~~. Sediment barriers ~~will be~~ ~~are~~ placed downgradient of the toe of the dumps where needed to provide protection against sediment movement from these dumps. Any sediment not contained by these forms of sediment control will be deposited either in the ephemeral channels or behind the impoundments. Natural vegetation in areas undisturbed by operations will also retard sediment movement downward.

The Melco Pit and ~~Melco South~~ waste dumps are situated near the ridge of the Dry Fork drainage basin (Plate III-A). The mining disturbances that could potentially increase sedimentation rates include haul roads and waste dumps. Sediment ~~will be~~ ~~is~~ controlled by using sediment barriers and the Melco impoundment to minimize sediment movement from the site. All uncontrolled sediment will be contained by the downgradient waste dump impoundment operated by Kennecott's Utah Copper Division.

The haul roads connecting the waste dumps to the Melco Pit ~~will be~~ ~~have been~~ sloped such that runoff from the road surface and the uphill watershed area will run along a series of connecting roadside ditches before being spilled into Dry Fork below. The ditches ~~will be~~ ~~are~~ excavated into bedrock therefore, the erosive forces of gully erosion during ditch runoff will be small. The roadside fill slopes offer the greatest potential for erosion as these slopes ~~will be~~ ~~are~~ much steeper than the hillside on which they lie. Sediment from these slopes will be carried along the roadside ditches to be deposited behind silt fences or the Melco impoundment. These structures ~~will be~~ ~~are~~ placed in the lower elevation of the Dry Fork channel (Plate III-A). The natural vegetation in the area will also retain some sediment as it moves from the disturbed areas.

Other operational sources of sediment ~~would be~~ ~~are~~ from the fill slopes created by the haul roads, leach pads, and process areas. This sediment ~~will move~~ down into the drainage channels and will eventually be carried to the railroad impoundments where sediment build-up will be monitored and cleaned out when necessary.

The potential impacts to Barneys Creek from the proposed mining facility will be caused mainly from haul roads, the North Melco dumps, the East Barneys pit and the Barneys Canyon pit (Plate III-A). The largest potential impacts to Barneys Creek will be from the erosion of waste rock dump haul road fill material during construction increasing sedimentation rates into the stream channel. This impact should be of short time frame. Other impacts to Barneys Creek could occur from haul road placement across the stream channel potentially causing degradation or aggradation of the stream channel upgradient and downgradient of the crossing. Any additional sediment loads entering the stream channel will be captured in the East Barneys pit or impounded behind the railroad impoundment downstream and will not leave Kennecott property. Due to the location of this impoundment, water quality stream flow monitoring is not planned. There will be no impact on Barneys Creek from Barneys Canyon open pit because the pit itself will prevent any discharge from occurring.

Topsoil stockpiles will also be potential sources of sediment release in the Barneys drainage (Plate III-A). The topsoil stockpiles will be located on the ridge-tops away from the stream channels to minimize topsoil discharge into the channel. To prevent the topsoil from washing away during heavy rainfall events, silt fences will be placed in areas around the stockpiles where the potential for erosion is high. These structures will be periodically checked and maintained when needed.

The Melco South mine dumps will be located just down gradient of the ridge and extend nearly to the base of the slope (Plate III-A). The angle of repose of these dumps will be steep so the potential for erosion is significant. Any sediment originating from these dump faces will be carried directly downgradient to be deposited behind the sediment barriers located in the drainage area below. Any sediment originating in the mine pit will also be deposited behind these sediment barriers.

~~Sediment generated by North BC South as well as a segment of the Melco access road will be captured by the temporary impoundment created by the South BC South Pit. The BC South dump surface will be slopes away from the dump and toward the upstream face of the dump to minimize erosion on the dump face. Because this temporary impoundment will be backfilled with waste, no sediment removal for maintenance purposes will be required. Sediment from the section of re-aligned Melco haul road located south of the North BC South pit will flow to the North BC South pit impoundment, as shown on Plate II-B. Any sediment released from the downstream face of the dump will be collected by silt fences which will be maintained as necessary. The B&G grade impoundment of Barneys Canyon prevents sediment and surface water from leaving Kennecott property.~~

Topsoil stockpiles will also be also potential sources of sediment release in the BC South drainage (Plate II-B). The topsoil stockpiles will be near the ridge-tops and away from the stream channels to minimize topsoil discharge into the channel. To prevent the topsoil from washing away during heavy rainfall events, silt fences will be placed in areas around the stockpiles where the potential for sediment release is high. These structures will be checked periodically and maintained as needed. In addition, the stockpiles will have been revegetated with a hydroseeder using the approved interim seed mixture described in Table 5.6.1.

~~The existing operational sediment control plan remains essentially the same with the~~

exception that the Melco and NBCS pits will not be used for long term sediment control. The same sediment control measures will be used for the Melco north dumps as for the south dumps.

The East Barneys pit will be is about 500 feet down stream of the intersection of the Barneys Canyon drainage with the Melco Haul road. Sedimentation will be was controlled by diversion ditches during mining operation. After mining operations ceased, an armored ditch was will be constructed at the alluvium - bedrock contact to channel water around the pit area.

At completion of mining, the East Barneys pit will remain became a permanent excavation in the bottom of the Barneys Canyon drainage and will collect and impounds any surface water flow entering the pit. The pit will have a significant capacity for holding water up to the 6080 elevation at which point water would discharge from the pit down the Barneys Canyon drainage channel. It is possible that surface water may be temporarily impounded in the bottom of the pit but this water is likely to drain by infiltration into the oxide rock of the pit an/or evaporate.

Pit slope stability studies completed by others have indicated that large-scale slope failures in the East Barneys pit are unlikely.

3.11 Disturbed Acreage

The total original (pre-1997) disturbed acreage for the project area is summarized in column 1 of Table 3.11-1. The disturbed acreage added in the 1997 modification is summarized in column 2.

The additional disturbance acreage for the project expansion is summarized in table 3.11-2

Table 3.11-1 Disturbed Area Summary

Site	Existing Original	New 1997	Total Acreage (Ac)
<u>PITS</u>			
Barneys			56.4
North BC South			8.0
South BC South			20.1
Melco			135.4
East Barneys (Expansion)	0.0	15.3	15.3
<u>ROADS</u>			
BC/SBC Haul Road			31.0
Process Roads	10.7	13.0	23.7
Main Access Road			4.6
BC Pit Area			11.0
Runaway Ramp			1.2
West Melco Haul Road			11.0
Melco East Haul Roads			18.0
SBC/NBC Haul Road			8.0
Melco Haul Road (Melco-SBC)			27.0
Melco-NBCS HR	11.0	21.0	32.0
East Barneys	15.3	3.7	19.0
Upper Barneys	0.0	14.0	14.0

ADMIN/PROCESS/SHOP

Administration Building			3.0
Process Building			13.0
Crushing/Screening			8.0
Shop			9.0
Potable Water Storage			2.0
Ore Stockpile			18.0
Gravel/Clay Pit #1			1.5
Clay Pit #2			2.5
Clay Pit #3			2.5
TV Adit	0.0	14.0	14.0

TOPSOIL STORAGE PILES

	<u>Existing</u>	<u>Original</u>	<u>New 1997</u>	<u>Total Acreage (Ac)</u>
A				2.7
C				8.5
D				4.3
E				2.7
G				5.5
H				1.5
I				3.6
South BC South				3.3
North BC South				2.3
BC South				3.9
J				0.5
K ₁				0.7
K ₂				2.3
K ₃				2.1
LP-5				5.5

WASTE DUMPS

Barneys 6300			66.7
6400/6500 West			46.0
UBW 6600			18.0
South Barneys			7.0
Melco 7480			12.1
Melco 7460			16.0
Melco 7300			83.0
Melco 7200			38.0
Melco 7100			47.0
Melco 6920	71.0	33.0	104.0
Melco Sulfide Repository			42.0 32.0
NBCS Sulfide Repository	(See North BC South Pit)		0.0
Melco South Dumps			135.0

LEACH PADS

BC-1			38.0
BC-2			35.0
BC-3	62.0	12.0	74.0
BC-4			32.0
BC-5	45.0	8.0	53.0
Solution Ponds			7.0

MISCELANEOUS

Substation
TOTAL

.4
1,382.8

Table 3.11-2 1997 Expansion Disturbance Area

Location/Site	Disturbance (acres)
Upper Barneys	14
TV ADIT	14
Melco 6920 Dump	33
Melco-NBCS HR	21
Leach Pads	33
East Barneys Pit	19
Total Additional Disturbance	134

Explanation of 1997 Expanded Disturbance Areas

- Upper Barneys (14 acres) - This disturbance is needed for access to remove topsoil for the north Melco dumps. In addition, it will provide access to the Melco 6920 dump for reclamation.
- TV Adit (14 acres) - This area contains a mineralized resource that will be examined for future mining.
- Melco 6920 Dump (33 acres) - The need for these additional 54 acres is the result of minor
- Melco - NBCS HR (21 acres) - changes in dump configuration which will make operations more efficient.
- Leach Pads (33 acres) - The increase at the leach pad area will accommodate a slightly larger disturbance of the BC-3 and BC-5 leach pad when they are pushed out to a 2:1 slope for reclamation. Also included are access roads to the clay pits.
- East Barneys Pit (19 acres) - This disturbance is needed to accommodate the area

encompassed by the pit and access road.

Proposed modifications to the permit boundaries made in 2000 would decrease the total area permitted for disturbance by about 20 acres. As of early 2000 the actual total disturbed acreage is 1187 acres. An additional 101 acres were disturbed in the past but have already been reclaimed.

4.0 Impact Assessment

The predicted impacts of the Barneys Canyon, BC South, East Barneys and Melco pits and waste dumps are summarized below.

4.1 Surface Water

Barneys Creek which flows from Barneys Canyon is intermittent within the project area at its headwaters and perennial over a mile reach adjacent to the south side of the Barneys Canyon open pit and mine dump. The location of Barneys Creek is shown on Plate I-A. It is anticipated that the project will have no impact on the perennial portion of Barneys Creek.

Other natural drainages in the area contain intermittent streams. The mining operations will interrupt several of the intermittent drainages in the area. The major interruptions will be located at the mine waste dumps which will fill areas where natural drainages currently exist. Additional project facilities influencing surface water runoff from the site include haul roads, open pits, the crusher site, and the leach facilities.

The operational runoff control plan has been designed so that the site will have zero discharge during storm events with a 10-year, 24-hour recurrence interval. Hence, no impact to offsite surface water is anticipated.

~~Despite the modifications that the project will make to the local ephemeral and intermittent drainage pattern, these modifications will have no effect on existing non-wildlife water use. The creation of impoundments on the site may have a beneficial affect on wildlife and livestock that will use the area following reclamation by providing seasonal water supplies.~~

The BC South operation will have ~~has had~~ a slight incremental effect upon ephemeral and intermittent drainages above that which has or will be created by the initially permitted Barneys Canyon operations. ~~The North BC South open pit will trap all sediment eroded from the BC South disturbed area, preventing offsite sediment impact to undisturbed drainages from these sources.~~ Sediment eroded from the outslope of the BC South waste dump prior to reclamation will be contained in the sediment control structures located in the ephemeral drainage below the waste dump. Earthen sediment control dams will provide sediment control in the ephemeral channel below the Melco dumps and the deepened Melco pit will act as a permanent sediment control impoundment. These structures will result in a minimal sediment impact to the channel of Dry Fork below. All sediment control structures will be maintained through the reclamation bond period and will be removed after bond release.

The Melco north dumps are located in Barneys Canyon and will affect approximately 7000 feet of the intermittent and perennial Barneys Creek. The waste dumps will be constructed in accordance with DWQ approved water management plans.

~~The East Barneys project is located in the Barneys Creek drainage, however, diversion conduits that will accommodate a 10-year, 24 hour event have been engineered and may be constructed around the pit perimeter (800') and back into natural drainage to minimize impact on production. The project duration is anticipated to be about 9 months. At closure,~~

the pit will be left in place and will serve as a stormwater containment and settling pond. Division of Water Quality has reviewed the project and agrees impact to surface or ground water will be de minimis (see Appendix L).

4.2 Ground Water

The Barneys Canyon mining project is anticipated to have no minimal impact on groundwater quality. because all All leach solutions will be are contained on site in lined surface impoundments or within the lined heap leach pads. The oxide waste rock dumps are composed of inert or net-neutralizing rock and are not expected to generate low quality drainage. The sulfide repositories will be capped to minimize sulfide oxidation and to prevent sulfide oxidation products from being mobilized.

The groundwater quantity may be altered by dewatering the Barneys Canyon pit during mining operations. Because of the planned depth of the Barneys Canyon pit, mining below the water table expected to occur has occurred. To control water in the pit, dewatering is was required using deep penetration production wells placed within the circumference of the pit. This pumping will removed water from the bedrock aquifer creating a cone of depression below the pit area. This cone of depression is not anticipated to influence has not influenced nearby water wells, given the low permeability of the aquifer. All intercepted pit water will be was utilized as necessary for dust control on the roads, and for process makeup water. Water rights have been filed with the Division of Water Rights for the volume of water to be used during operations. It is not anticipated that inflow to the pit will yield more water than can be used during operations, however, if this takes place, excess water will be discharged into one or more nearby drainages where the water will impound behind the railroad impoundments on the eastern edge of the property. No discharge into the live stream channel of Barneys Creek will take took place. The water will infiltrate into the ground behind the grade. No discharge permit will be needed because this water will not leave the property. A pit lake currently occupies the pit floor. This lake is pumped intermittently to provide water for road watering and for process water make-up. This water is of drinking water quality.

The Melco mine pit and adjacent waste dump will also have minimal impacts on the groundwater. Dames and Moore (1988) determined, based upon piezometers completed in exploration drill holes, the approximate elevation of the water table beneath Melco to be 6800 feet (AMSL). Subsequent exploration drilling to elevations below 6500 feet has not intersected water, indicating that the water table probably lies below the 6500' elevation. Current mine plans reflect the maximum possible pit depth and indicate that the elevation of the pit bottom will not lower than a depth of 6900 feet. Therefore, no impact upon groundwater quantity or quality from the Melco pit is anticipated.

Since the proposed BC South pits will do not intercept the water table, significant accumulations of water will not occur in the pits. Therefore, no significant impact on ground water quality is expected to occur. Similarly, the lack of significant water accumulations in the pits will result in negligible impact to wildlife.

The bottom of the expanded Melco pit will be at approximately 6460 6480 feet AMSL. Extensive additional exploration drilling in the area indicates that the water level measured

in hole MC-31 was a localized anomaly and that the water table is below 6400 feet AMSL. To date, no significant quantities of water have been intercepted in the planned pit area. Therefore, minimal impacts to groundwater quality from the Melco Pit are anticipated.

4.3 Soil Resources

Operations and post-operational runoff control plans prevent the erosion of in-place and stockpiled topsoils. Due to steep slopes and related worker safety requirements, variances for topsoil salvaging and replacement are being sought, as discussed in Section 6.0. With the exception of areas proposed for variances, topsoil will be salvaged from all other disturbed areas. Sufficient topsoil will be salvaged to ensure that all surfaces receiving topsoil during reclamation will be covered by at least one foot six inches of topsoil. Replaced topsoil will be revegetated with an appropriate seed mix both for the purpose of erosion prevention and for wildlife and cattle forage. Soil stockpiles will be protected from erosion with an interim cover of grass. Soil resources will be, therefore, be protected to the maximum extent that prudent and safe mining practices allow.

All areas safely accessible to excavating equipment will be stripped of available topsoil and the topsoil will be stored in stockpiles as described in Section 3.9.

4.4 Critical Wildlife Habitats

The open pit highwalls will be the only parts of the disturbed areas that will not be reclaimed and, therefore, will not be available as high-quality wildlife habitat as they are now. The project area is important habitat to both deer and elk; however, the loss of forage and cover will be minimal in the context of the project as a whole. Possible changes in migration routes will only be temporary given the short life of the mine. This minimal impact to the wildlife habitat will be mitigated somewhat by the creation of wildlife watering sites in impoundments in the Barneys Canyon pit and behind mine dumps in the East Barneys pit. In addition, Kennecott's practice of allowing no hunting on its property will eliminate the impacts of combined hunting pressure and habitat loss of the herds.

The Division of Wildlife Resources (DWR) was consulted has been informed of the Barneys Canyon project asking for their recommendations concerning elk calving habitat and elk and deer winter range. Kennecott and the Division of Oil, Gas and Mining have been informed by the DWR that the project operations will not adversely affect elk calving habitat and that the only mitigation necessary will be to reduce travel in the main branch of Dry Fork and that portion of Barneys Canyon above the 7000 foot elevation as much as possible during calving season. Neither the Melco or Barneys Canyon operations will require access to these areas. Kennecott cannot of course restrict access to private landowners or lease holders who may require access to properties in these canyons or to its own personnel who may have to enter the main branch of Dry Fork for the purposes of property maintenance or water monitoring.

4.5 Air Quality

Air emissions resulting from the mining operations will be fugitive dust and diesel emissions. A number of point source air emission sources will occur within the process

plant area. The principal point source emissions will be is dust from the crushing and screening operations. Detailed air emissions calculations are incorporated in Kennecott's "Notice of Intent to Commence Mining and Gold Processing Operations, Barneys Canyon Project, Salt Lake County, Utah, Submitted to Utah Division of Air Quality" (AQNOI).

Kennecott's emission control plans for the project will incorporate, as Utah Division of Air Quality regulations require, best available control technology for suppression of emissions. The controlled emissions calculations in the above-referenced AQNOI indicate that the Barneys Canyon project will not be is not a major emission source under Federal Prevention of Significant Deterioration (PSD) regulations. Therefore, it is concluded that the project will does not cause a significant deterioration of air quality in the area.

Detailed estimates of air emissions are included in the Technical Report submitted to the Division of Air Quality (DAQ) in March, 1992. A revised Approval Order for Barneys Canyon Mine was issued by DAQ in September, 1992, December 1993, February 1994 and December 1999.

A The revised Approval Order was obtained from the Utah Division of Air Quality on December 20th, 1993 to allowed increased dump heights. This new approval order allowed the height of the waste dump lifts on the south side of the Melco Mine to increase from 500 feet to 1000 feet, and for all other project waste dump heights to increase from 300 feet to 500 feet. On February 9th, 1994 a revised Approval Order was obtained which covers the sulfide flotation plant and associated infrastructure. The December 1999 Approval Order addresses modifications that replaced the pyrometallurgical process with a hydrometallurgical process for gold recovery.

4.6 Public Health and Safety

All mining and process operations will be operated in full accordance with safety regulations administered by the Federal Mine Safety and Health Administration (MSHA). The occupational safety and health program will not only protect worker safety and health, but also that of members of the general public that will visit the property. Maintenance of a safe on-site work environment and adherence to the air emission control program will insures that no harmful airborne particulate or chemical emissions will leave the property.

Kennecott, by virtue of its extensive land ownership in the area, controls all access to the property. Hence, an effective safety buffer zone is adjacent to the project site. In addition to overall controlled access and the site safety program, other specific safety measures have been will be taken to further ensure public safety. These measures will include locked gates at all access points when operations are dormant, fences around all process areas, and security guards to control public access at all times during the life of the project. Warning signs and safety berms will be installed adjacent to pit highwalls following completion of mining as part of reclamation. In addition, all process facilities will be reclaimed after any cyanide-bearing or other toxic-materials-bearing wastes are neutralized or safely removed from the property.

~~The East Barneys Project will not leave any shafts or tunnels at the end of the project. Therefore all safety considerations are covered under the existing permit requirements.~~

5.0 Reclamation Plan

5.1 Post-mining Land Use

The post-mining land use for the reclaimed mine dumps and leach pads will be for wildlife habitat and livestock grazing. The post-mining land use for the open pits that are not backfilled will be sediment control. The pits will contain sediment eroded from the open pit walls. The Barneys Canyon and East Barneys pits will serve a secondary purpose of providing a source of water for wildlife. Reclamation treatments are summarized in the following text and on the Reclamation Treatments Maps. (Plate 96-1 and Plate 96-2)

5.2 Demolition and Disposal

5.2.1 Facilities Removal

All non-earthen facilities will either be transported from the site for use elsewhere, salvaged, or demolished, if necessary. Any paved surfaces will be removed and handled as demolition debris as described below. The various facilities will be removed or disposed as follows:

crushers, conveyors, and mobile equipment will be salvaged or transported from the site for use elsewhere;

buildings will be salvaged or demolished and removed from the site, unless they are required for other non-mining use;

powerlines and substations will be removed and salvaged upon completion of the operations, unless they are preserved for a continued, non-mining use;

fuel and explosives storage facilities will be salvaged or transported off-site for disposal; and

fences will be removed and salvaged or junked following completion of reclamation.

Necessary security measures will be maintained until satisfactory reclamation has been achieved.

5.2.2 Demolition Debris Disposal

Demolition debris that cannot be salvaged will be deposited in a permitted solid waste landfill.

5.2.3 Hazardous Substances

Leach testing of waste materials has demonstrated that materials left on site following reclamation will not be hazardous. As discussed below, each heap leach installation will either be rinsed to neutralize residual cyanide or will have its existing water management

systems maintained to collect and treat the drain-down until the residual cyanide degrades naturally, and have its cyanide neutralized prior to regrading and reclamation. The oxide mine dumps will not be toxic or acid generating. The sulfide repositories will be capped in order to allow vegetation to become established and to minimize water infiltration. Any other process waste materials that accumulate on site, either in containers or impoundments will be used or disposed of properly, taking into account potential hazardous characteristics.

5.3 Regrading and Process Facilities Closure

Proposed procedures for mine dump and process facilities regrading, open pit and haul road reclamation, and/or closure are presented below and depicted on the Reclamation Treatments Maps, Plate 96-1 and Plate 96-2.

5.3.1 Open Pits

The East Barneys Canyon, Melco, and North BC South and portions of the Barneys pits will not be used for waste rock disposal and, will not be backfilled. The pits will serve as catchment basins and prevent release of sediment eroded from the pit walls.

The South BC South open pit will be partially backfilled with waste from the North BC South open pit, as shown on Plate IV-B. The pit will be backfilled as shown on Plate IV-B and Figures 5.3-1 and 5.3-2. The South BC South pit will be non-water-impounding, and the pit fill will be recontoured to mimic natural landforms. However, the terraces will be sloped toward the remaining highwalls for the purpose of runoff control and sediment retention. The non-backfilled portions of the pits will not be revegetated or topsoiled. Safety berms or fences will be installed along the margins of all pit highwalls. The Barneys Canyon Pit will be partially backfilled with waste from the East Barneys Project. The North BC South open pit will be backfilled with sulfide-bearing waste rock from the Melco pit.

The pit bottoms at Melco will be covered with six inches of topsoil and revegetated (Plates 96-1 and 96-2). Pit benches that are safely accessible to equipment following completion of mining at each pit will be topsoiled to the extent that topsoil is available.

The East Barneys pit will remain in its as-built condition within the bottom of the Barneys Canyon drainage. The operational drainage diversion used to divert Barneys Canyon around the pit during operations will be backfilled and reclaimed. The diversion berm constructed to block the natural Barneys Canyon Channel and divert it into the temporary ditch will also be removed from the natural channel to open the natural channel to a free-flowing condition. A permanent reclamation channel will be constructed to drop the Barneys Canyon channel into the East Barneys pit in a stable fashion.

The permanent reclamation channel will begin at the contact between alluvium and rock within the pit and be graded at an overall 33% grade or less uphill to the natural Barneys Canyon channel elevation (see Appendix DII(c)). The bottom of this channel excavation will be approximately 8 feet wide and the sides slopes will be approximately 4h:1v or flatter. The design flow for this permanent channel is 195 cfs which is the 100-year, 24-hour peak flow calculated by JBR for the Barneys Canyon watershed. This calculation used the

same watershed configuration and computer model last used in the November, 1993 NOI except that the average weighted Curve Number for the watershed was increased from 48 to 57 to take into account the approximately 300 acres of reclaimed overburden dumps that will exist in Barneys Canyon when the Melco wasterock dumps are completed.

The flow conditions in the permanent channel were calculated using the SECAD 3 computer program (Appendix DII(c)). The calculated flow velocity of 13 fps will required the use of a 4-foot thick blanket of riprap, having a D_{50} of 15 inches over the bottom of the channel and extending at least 2 feet up the channel sides. This same riprap will extends up the natural Barneys Canyon channel for approximately 50 feet uphill of the start of the constructed channel to protect this transition section. There will be is no need for a similar riprap blanket at the outlet of the channel where it discharges onto the rock surface of the East Barneys pit.

The East Barneys pit will contain the water draining down the Barneys Canyon channel. The pit will not be self draining and will hold water within the pit bottom up to the 6080 foot elevation before any additional water will drain over the east end of the pit and down the natural Barneys Canyon channel. All the rock in the East Barneys pit is expected to by oxide material with no sulfidic mineralization exposed on the walls of the East Barneys pit is oxidized and so is inert or net neutralizing. Therefore, the water in the pit should will not contact any acid generating material and should have no deleterious water quality impacts on local surface water or ground water quality. The water contained in the pit is expected to be ephemeral to intermittent in nature and will be available for seasonal use by wildlife as a water source. The local water table is below the bottom elevation of the pit so a perennial water impoundment is not expected to occur, but a shallow perched pond does occupy the pit floor. Any overflow from the pit will flow down the natural Barneys Canyon channel.

5.3.2 Mine Waste Oxide Waste Dumps

Waste dump out slopes will be have been developed during mining at a slope of approximately 37 degrees. All Barneys Canyon pit mine dumps will be regraded to a maximum slope of 2.5h:1v (22 degrees). The regraded bench out slopes will be pitted for the purpose of runoff and erosion control. The regraded Barneys Canyon dump out slopes will be covered with approximately six inches of topsoil and revegetated according to the revegetation plan presented in Section 5.5 through 5.8. The top of the dump will be ripped to 24 inches and will receive six inches of topsoil and revegetated as outlined in Section 5.5-5.8.

The BC South waste rock dump will be regraded to a maximum slope of 2.5h:1v (22 degrees). The regraded bench out slopes will be roughened using a pitter to create a series of depressions on the dump out slope surface. These depressions will function as sites for concentrated revegetation and for the purpose of runoff and erosion control. The regraded BC South dump out slopes will be covered with approximately six inches of topsoil prior to excavation of the depressions described above and revegetated according to the revegetation plan presented in Section 5.5 through 5.8. The top of the dump will be ripped to 24 inches and will receive six inches of topsoil and revegetated as outlined in Section 5.5-5.8.

The configurations of the Melco mine south dumps have been revised as a result of the decision to increase the size of the Melco open pit. Selected out slopes of the 7240 and 7460 dumps outlined on the Reclamation Plan (Plate 96-1) will be regraded to a maximum slope of 2.5h:1V and revegetated as outlined in Section 5.5 - 5.8. The south out slope of the Melco South dumps will not be regraded because such activities would result in additional disturbance of the watershed including adjacent hillsides and the ephemeral channel in the canyon below. The out slope of these dumps will be hydroseeded using mulch and tackifier for stabilization and erosion control.

The configuration of the Melco dumps have been designed to eliminate upgradient watershed runoff water from draining into the pit at mine closure.

All of the out slopes of the Melco north dumps will be regraded to a maximum slope of 2.5h:1v and the dump surfaces and slopes covered with approximately six inches of topsoil and revegetated.

5.3.3 Heap Leach Pads and Solution Ponds

~~When a leach pad is completed, it will be rinsed to remove the cyanide solutions, drained, and left for reclamation at the close of all operations. The neutralization criteria will be determined by the~~ When a leach pad is removed from operation it will either be rinsed or will be designed to allow for long-term water collection and treatment. The final disposition of the leach pads has not yet been determined, but will be selected in conjunction with the Water Pollution Control Committee or the Division of Water Quality (DWQ) at the time of decommissioning. The neutralization management criteria will ensure that no degradation of the surface or groundwater quality or beneficial uses thereof takes place following regrading and revegetation of the heaps.

~~The closure process will begin by terminating the addition of NaOH and NaCN to the barren pond water and allowing the pH of the circulating leach solution to gradually adjust to a natural pH of about 7. The neutral solution pH will cause the CN in the wet ore to gradually be converted to volatile HCN which will be liberated to the air filled voids within the heap. This HCN will gradually and harmlessly diffuse to the surface of the heap where it will be released into the atmosphere. The final neutralization procedures will be described in a closure plan to be reviewed and approved by DWQ six months prior to beginning neutralization of any pad.~~

~~When the heap has been neutralized, the makeup water flow to the barren pond will be turned off and the water in the pregnant intermediate and barren ponds will either be pumped to another active leach pad or evaporated. The ponds will then~~ When the solution ponds are no longer needed for water management they will be allowed to dry and remaining sludges will be sampled for EP toxicity characteristics. All solid wastes will be properly disposed of taking into account their chemical characteristics. The pond liners will then be removed from the anchor trenches and folded into the ponds. The pond areas will then be backfilled with earth, and topsoil from nearby stockpiles will be spread evenly over the regraded surface.

After the cyanide concentrations in the leach heaps have been sufficiently reduced by rinsing or natural degradation, they will be re-contoured to gradually rounded slopes of 2.5h:1v or less. The recontouring process will include pushing neutralized heap material over the pad marginal dikes to cover the exposed liner. Before placing material outside the liner, it will be tested to insure it poses no threat to surface or groundwater quality. Topsoil from the stockpiles will then be spread evenly over the recontoured surface and the specified vegetation mixture will be established.

The rinsed leach solution pipelines will be taken up and removed from the site. The liners in the pipeline trenches outside of the leach pads will be removed from the trenches, rolled up, and disposed in the solution pond excavations prior to their being backfilled. The trenches will then be regraded, topsoiled, and revegetated.

5.3.4 Haul Roads

All haul road surfaces will be covered with six inches of topsoil and revegetated as described below in Sections 5.3 and 5.4 (Plates 96-1 and 96-2). Haul road outslopes and cut slopes will be hydroseeded, using methods described in Section 5.4.3.

5.3.5 Sulfide Repositories

Sulfide-bearing waste rock will be placed in the Melco and North BC South Sulfide repositories in ten-foot lifts so that vehicle traffic will compact the rock. This will minimize the infiltration of oxygen and water into the material. The sulfide-bearing material will then be capped with a minimum of ten feet of inert or net-neutralizing oxide waste rock and three feet of fine-grained topsoil. The cap will have a minimum slope of ten degrees to maximize runoff and to promote lateral vadose zone groundwater flow in the upper cap.

5.4 Soil Materials

5.4.1 Topsoil Application

All disturbed areas, with the exception of the open pits, the clay borrow pits, and the Melco South dump outslopes, will be covered with topsoil. All sites will be covered to having a nominal thickness of six inches except for the sulfide repositories which will be covered to a depth of three feet with fine-grained topsoil. Areas to receive topsoil are described in Section 5.4.3.

Kennecott commits to placement of at least six inches of topsoil on all disturbed slopes having an outslope of 2.5h/1v or less. A revegetation test plot program, will be developed to determine if the Melco dump material can be directly revegetated. However, the design of this program will not be included in the mining and reclamation plan at this time.

5.4.2 Topsoil Handling

The topsoil redistribution will be carried out during the summer in anticipation of fall seeding. Thus, the soil will be relatively dry and compaction minimized. Minimizing topsoil compaction is very important considering the clays and clay loams present in many of the

soil types, especially the Harker and Dry Creek soils. Topsoil materials will be moved with a scraper or loader-dump truck operation and will require some spreading with a blade. The contractor operators will be cautioned to keep the soil surface rough and to avoid balding to obtain a smooth surface. Evenness of depth will be sacrificed for roughness of surface.

To relieve compaction, all topsoiled areas will be ripped to a depth of at least 24 inches with the rippers set at 12 inch spacing.

5.4.3 Topsoil Balance

Topsoil sources by soil type are summarized in Table 5.4-1. Table 5.4-2 presents the topsoil volumes to be applied to the various sites. The total topsoil requirements listed at the bottom of Table 5.4.2 are based upon the total planned disturbed area that will require topsoil applications as of May 2000. A swell factor of 21 percent, one-half that estimated by the Caterpillar Performance Handbook (Caterpillar, 1988), was applied to the in-place topsoil volume. The topsoil excess will be applied as site-specific conditions require or used at other Kennecott properties or put to beneficial use by other outside sources.

Soil types and volumes present in the for Melco 1997 expansion study area are detailed included in Table 2.4-1 and on Plate III-C. Much of this soil resides on steep, tree-covered slopes and will not be recovered because of safety concerns, but the quantity of soil in the expansion area (prior to salvage losses and unsalvaged slopes) is approximately double the amount required for the reclamation plan to reclaim the 1997 expansion area. Table 2.4.3 details the topsoil requirements for the disturbed areas added by the 1997 expansion. Kennecott will salvage topsoil from areas where salvaging operations can be safely conducted. This topsoil will predominately be salvaged from the main drainage of Barney's Canyon where access is easy and the soil depth the greatest.

Table 5.4-1 Topsoil Sources by Soil Types

<u>Soil Type</u>	<u>Volume, Cu.Yds.</u>
Bradshaw-Agassiz	125,194 +8910 = 134,104
Fitzgerald	54,890
Harker-Dry Creek	318,634
Gappmeyer	51,080
Dry-Creek Copperton	402,526
Wallsburg	38,650
Copperton	<u>20,167</u>
Total Topsoil Available	<u>1,020,051</u>
Swell Factor of 21%	<u>214,211</u>
Total After Swell	<u>1,234,262</u>

Table 5.4-2 Topsoil Applications by Sites

<u>Site</u>	<u>Acreage (Ac)</u>	<u>Volume (CY)</u>
ROADS		
BC/SBC Haul Road	31.0	28,758
Process Roads	10.7	9,926
Main Access Road	4.6	4,267
BC Pit Area	11.0	10,204
Runaway Ramp	1.2	1,113
West Melco Haul Road	11.0	10,204
Melco East Haul Road	18.0	16,698
SBC/NBC Haul Road	8.0	7,421
Melco Haul Road (SBC-Melco)	27.0	25,047
East Barneys A**	19.0	17,626
ADMIN/PROCESS/SHOP		
Administration Building	3.0	2,783
Process Lab	13.0	12,060
Crushing/Screening	8.0	7,421
Shop	9.0	8,349
Potable Water Storage	2.0	1,855
Ore Stockpile	18.0	16,698
Gravel/Clay Pit #1	0.0	0
Clay Pit #2	2.5	2,319
Clay Pit #3	2.5	2,319
SBC High Wall	9.0	16,698
SBC Pit Fall	9.0	8,349
Upper B.C. Disturbance**	14.0	12,987
WASTE DUMPS		
Barneys 6300	37.0	37,663
6400/6500 West	46.0	42,673
UBW 6600	4.0	3,711
UBW 6600 A **	14.0	12,987
South Barneys	7.0	7,050
Melco 7480	12.1	12,356
Melco 7460	16.0	16,698
Melco 7300	83.0	82,562
Melco 7200	38.0	37,107
Melco 7100	47.0	47,125
Melco 6920	57.0	59,185
Melco 6920 A **	47.0	43,600
Melco-NBCS HR	11.0	10,946
Melco-NBCS HR A **	21.0	19,481
Melco Sulfide Repository	12.0 32.0	11,132 154,880
NBCS Sulfide Repository	8.0	7,421 38,720
Melco South Dumps	72.0 52.0	71,430 51,588
LEACH PADS		

BC-1	38.0	35,251
BC-2	35.0	32,468
BC-3	44.0	40,817
BC-3A **	18.0	16,698
BC-4	32.0	29,685
BC-5	30.0	27,830
BC-5 A **	15.0	13,915
Solution Ponds	7.0	<u>6,494</u>

1997 Melco and Satellite Expansion (Table 5.0-4 5.4-3) 147.4 134.0 237,320 124,307

Total Demand 982.6 1116.6 949,391 1,228,899
(including 1997 expansion and 2000 repository cap modification)

Total Available 1,279,700 1,234,262

Topsoil Balance (Excess) (330,303 5363)

Table 5.4-3 1997 Expansion Topsoil Application Requirements

Location/Site	Disturbance (acres)	Topsoil (cubic yards)
Upper B.C. Disturbance	14	12,987
UBW 6600	14	12,987
6920 Dump	33	30,613
NBCS HR	21	19,481
Leach Pads	33	30,613
East Barneys Pit	19	17,626
Reclamation Requirements	134	124,307

In determining the topsoil balance for reclamation of the waste dumps and roads, it has been assumed that inefficiencies in topsoil salvaging may result from excavating equipment working on the steeper slopes and the reduction of salvageable topsoil in some wooded areas caused by topsoil clinging to large tree roots. It was assumed that this possible loss would be balanced by ordinary swelling following salvaging and the added volume that will be created by mixing vegetation with the soil during salvaging and stockpiling operations.

The modification in the area permitted for disturbance that was proposed in March, 2000 will decrease the acreage that needs to be reclaimed by up to 20 acres and so will result in a

~~small reduction in topsoil requirements~~

5.5 Seedbed Preparation

Topsoiled areas will require seedbed preparation only if seeding does not closely follow placement of topsoil. If seeding occurs more than 60 days following topsoil placement, the soils will be scarified or disked prior to seeding. Seeding on topsoiled dump surfaces will be accomplished with a pitter, range drill or hydroseeder.

5.6 Seed Mixture

Three different seed mixtures are proposed for the Barneys Canyon project. Species were derived from the plant community descriptions and experience with other revegetation projects in the Oquirrh Range, along with input from DOGM.

Areas which are proposed to receive topsoil will be revegetated with the seed mix shown in Table 5.6-1. Outslopes of the Melco, 7200 and 7300 dumps have been granted a variance from the topsoil redistribution requirement by the Division. The seed mixture recommended for non-topsoiled surfaces is shown in Table 5.6-2. The two sulfide repositories located at Melco and North BC Pit will be revegetated using the seed mix presented in Table 5.6-3.

Revegetation will be carried out in the manner described in Section 5.7, including hand-seeding ~~planting~~ of tube stock ~~on non-topsoiled areas and on the sulfide-repository caps~~

~~Areas that have been hydroseeded and are safety accessible will receive an even mixture of Gambel oak, rabbitbrush and snowberry tube stock planted in clumps of 3 to 5 each will be planted at a rate of 135 plants per acre, three times the application rate proposed for the topsoiled surfaces. The planting procedure for each clump will begin with excavation of an over-sized hole which will be lined with mulch. A slow release fertilizer pellet will be placed at the bottom of each hole. The tube stock will then be planted and the hole filled and tamped. A mixture of legume seed will be hand-applied to the surface of each planting site for enhancement of nitrogen development in the planting medium. The Division will establish a survival rate, as a percentage of total seedlings planted, for the un-topsoiled dumps surface. This survival rate is currently estimated to be 50 percent. This survival rate will be achieved at the end of the three year period following completion of reclamation.~~

As a result of discussions with Department of Wildlife Resources (DWR) personnel, it has been agreed that additional legumes and forbs will be added to the revegetation seed mix to improve the spring forage for deer and elk in the reclaimed areas of the project. DWR personnel feel that the addition of these species to this large reclaimed area will significantly improve the early spring forage above what is currently present. This improved forage over this large reclaimed area will provide enhanced habitat to both deer and elk. Therefore, the current reclamation plan with the modified seed mix is, according to DWR, the best means of enhancing the post-mining use of the reclaimed area.

Table 5.6-1 Seed Mixture for Topsoiled Areas

<u>Common Name</u>	<u>Scientific Name</u>	<u>*PLS(1) lbs. acre</u>
Grasses		
bluebunch wheatgrass	<u>Agropyron spicatum</u>	3
intermediate wheatgrass	<u>Agropyron intermedium</u>	3
great basin wildrye	<u>Elymus cinereus</u>	3
canby bluegrass	<u>Poa canby</u>	1
cereal rye	<u>Secale cereale</u>	4
Legumes		
yellow sweetclover	<u>Melilotus officinalis</u>	1
cicer milkvetch	<u>Astragalus cicer</u>	2
ladak alfalfa	<u>Medicago sativa</u>	2
Forbs		
yarrow	<u>Achillea millefolium</u>	0.2
small brunette	<u>Sanguisorba minor</u>	1.5
Shrubs		
basin big sagebrush	<u>Artemisia tridentata</u>	0.5
rubber rabbitbrush	<u>Chrysothamnus nauseosus</u>	0.5
Total		21.7

(1) PLS = Pure Live Seed

- Rates reduced by 30% if drill seeded.

Western wheatgrass (Agropyron smithii) may be substituted for bluebunch wheatgrass if necessary.

Table 5.6-2 Seed Mixture for Non-Topsoiled Areas

<u>Common Name</u>	<u>Scientific Name</u>	<u>PLS(1) lbs/acre</u>
Grasses:		
regreen wheatgrass	<u>Triticum x Agropyron</u>	2.5
intermediate wheatgrass	<u>Agropyron intermedium</u>	2.5
bluebunch wheatgrass	<u>Triticumx agropyron</u>	2.5
indian rice grass (2)*	<u>Orxyopis hymenoides</u>	2.5
streambank wheatgrass	<u>Agropyron riparium</u>	2.5
Lequmes:		
cicer milkvetch	<u>Astralagus cicer</u>	1
yellow sweetclover	<u>Melilotus officinalis</u>	0.5
palmer penstemon	<u>Penstemon palmeri</u>	0.5
alfalfa	<u>Medicago satira</u>	1
mountain lupine	<u>Lupinus alpestris</u>	1
Forbs:		
yarrow	<u>Achillea lanulasa</u>	0.2
small brunette	<u>Sanguisorba minor</u>	1
Plantings:		
gambel oak	<u>Quercus gambelli</u>	135 #1/A(2) 45/acre(2)
snowberry	<u>Symphoricarpus albus</u>	135 #1/A(2) 45/acre(2)
rabbitbrush	<u>Crysothamnus nauseosus</u>	135 #1/A(2) 45/acre(2)

(1) PLS = Pure Live Seed (these rates apply to broadcast or hydroseeding; for areas where seed is to be drilled, the application rates will be reduced by 30%)

(2) Tube stock will be planted in clumps at a rate of 45 plants of each species per acre, for a total of 135 seedlings per acre. If required, protective measures, such as netting or tubing will be applied to each clump of tublings seedlings.

Western wheatgrass (Agropyron smithii) may be substituted for bluebunch wheatgrass if necessary.

Mountain snowberry (Oreophilus symphoricarpus) may be substituted for common snowberry if necessary.

Table 5.6-3 Sulfide Repository Cap Seed Mixture

<u>Common Name</u>	<u>Scientific Name</u>	<u>PLS(1)</u> <u>lbs/acre</u>
Grasses:		
regreen wheatgrass	<u>Triticum x Agropyron</u>	6.5
intermediate wheatgrass	<u>Agropyron intermedium</u>	3.5
bluebunch wheatgrass		3.5
bluebunch wheatgrass	Agropyron spicatum	2
intermediate wheatgrass	Agropyron intermedium	2
great basin wildrye	Elymus cinereus	2
canby bluegrass	Poa canby	1
mountain rye	secale montanum	3
Legumes:		
yellow sweetclover	<u>Melilotus officinalis</u>	1.5 0.5
small brunette	<u>Sanguisorba minor</u>	1.5
cicer milkvetch	Astragalus cicer	2
ladak alfalfa	Medicago sativa	1
Forbs:		
white yarrow	Achillea millefolium	0.1
small burnett	Sanguisorba minor	1.5
palmer penstemon	Penstemon palmeri	0.5
Shrubs		
mountain big sagebrush	Artemisia tridentata vaseyana	0.2
rubber rabbitbrush	Chrysothamnus nauseosus	0.5
forage kochia	Kochia prostrata	0.5
woods rose	Rosa woodsii	1
Total		17.6
Seedlings		
gambel oak	Quercus gambelli	150 plants/acre
common snowberry	Symphoricarpos albus	150 plants/acre
bitterbrush	Purshia tridentata	150 plants/acre
curl leaf mountain mahogany	Cercocarpus ledifolius	150 plants/acre

(1) PLS = Pure Live Seed

Western wheatgrass (Agropyron smithii) may be substituted for bluebunch wheatgrass if necessary.

Mountain snowberry (Oreophilus symphoricarpos) may be substituted for common snowberry if necessary.

5.7 Seeding Methods

Topsoiled dump top surfaces will be seeded with a range drill and topsoiled dumps slopes will be seeded with a pitter or hydroseeder. Seeding will take place in the fall prior to snowfall. The seeding depth for drill-placed seed will be 0.5-0.75 inches at the rate of application specified in the seed mixtures presented in Section 6.5 5.6. ~~Since the seed drilling will be the last step in revegetation, the fertilizer and mulch will be turned into the soil by the disks on the drill.~~

The outslope of the Melco 7300 and the south outslope of the Melco 7200 dump will be seeded with a hydroseeder. ~~In addition, tube stock will be hand-planted the outslopes that are safely accessible.~~ The outslopes and cut slopes of all haul roads (Plate IV-B) will also be hydroseeded, using the seed mixture shown in Table 5.6-2. ~~Both seed and mulch will be applied to the hydroseeded areas.~~

~~Tube stock seedlings will be planted on areas where topsoil is not applied and on top of the sulfide-bearing waste rock repository caps. The planting stock will be tube stock and will be hand planted in early spring at snowmelt. Planting will be in clumps of three at the planting according to the rates as shown in Tables 5.6-2 and 5.6-3 5.6-4. On angle of repose slopes, a slow release fertilizer pellet will be placed in the bottom of each hole along with the seedling. On flat surfaces or reduced slopes that can be easily accessed, the seedlings will be planted in clumps of three. The planting procedure for each clump will begin with excavation of an over-sized hole that will be lined with mulch. A slow-release fertilizer pellet will be placed at the bottom of each hole. The tube stock will then be planted and the hole filled and tamped.~~

~~The clumps will be planted in sites with aspect and slope to maximize moisture entrapment. A small catch basin will be constructed around the three plants.~~

Kennecott proposes to establish the minimum revegetation standard for the 7300 and 7200 angle of repose dump slopes at Melco by performing vegetation transects of south facing angle of repose fill slopes along the Melco haul road or by other appropriate means as determined in conjunction with DOGM. These slopes were hydroseeded in 1990 using seed mixtures very similar to those prescribed in the Mine Reclamation Plan (MRP).

Kennecott commits to applying to the 7300 and 7200 dump south outslopes the currently approved reclamation treatment for the Melco 7200 dump outslopes unless, prior to reclamation, Kennecott and DOGM jointly adopt a modified program of revegetation. Kennecott will cooperate fully with DOGM in the evaluation of alternate reclamation techniques for these dump outslopes. If the success of the revegetation efforts on the 7300 dump establishes a higher revegetation standard, it will be applied to the 7200 dump angle-of-repose slopes.

5.8 Fertilization and Mulching

5.8.1 Fertilization of Topsoiled Areas

The goal of fertilization is to raise the available phosphorus and nitrogen concentrations to 25 ppm, and 0.02 ppm, respectively and to maintain the organic matter at 1.5 percent. This will be accomplished by utilizing green alfalfa hay in combination with diammonium-phosphate fertilizer in the fall seeding schedule. This fertilizer will provide the nitrogen required for seedling growth in the first growing season. The soils that will be used for topsoiling have adequate nutrient contents; therefore, no additional fertilizer is necessary for areas where topsoil is applied.

During the planting of the shrub-species seedlings, a fertilizer tablet or teabag of 20-10-5 will be inserted in the hole at root depth and irrigated. These slow release tablets are designed to provide fertilization to the seedlings for two years.

The diammonium-phosphate fertilizer 18-46-0 at 310 pounds per acre will provide 49 pounds per acre of nitrogen and 64 pounds per acre of P_2O_5 .

5.8.2 Fertilization of Non-Topsoiled Areas

Fertilization of non-topsoiled areas (Melco South dump outcrops) will be identical in chemical fertilizer type and quantity as described for the topsoiled area in Section 5.8.1. For areas being reclaimed without topsoil, nitrogen and phosphorus will be provided by a diammonium-phosphate fertilizer (18-46-0). At 310 pounds per acre this will provide 49 pounds per acre of nitrogen and 64 pounds per acre of P_2O_5 . Fertilizer, mulch, and tackifier will be applied in a slurry by hydroseeding methods.

5.8.3 Mulching

Hydromulch and tackifier will be applied to all areas that are reclaimed by hydroseeding.

Green alfalfa hay will be applied to all topsoiled surfaces. As a mulch, it will increase the organic content of the soils, increase the soil moisture holding capacity, and provide nutrients for microorganism colonization. The buildup of microorganisms and the resultant increase in nutrient cycling capability in the soils will facilitate plant establishment and growth.

The hay mulch will be applied at the rate of 4,000 lbs/acre following ripping and prior to seeding. The use of a mulcher or mulch chopper to blow in the hay will allow for even distribution and dismemberment of stems to allow the disks on the seed drill to turn in the hay particles.

The hay at 4,000 pounds per acre will provide nitrogen, phosphorus, and potassium at the rates of 100 pounds per acre, 20 pounds per acre, and 84 pounds per acre, respectively.

On sites where the seed drill is unable to function and broadcast seeding is used, the hay will need to be covered with soil by backdragging or raking.

~~Runoff from upgradient watersheds will no longer be routed into the NBCS and Melco pits at mine closure.~~

5.9 Surface Water Hydrology and Sediment Control

Post-reclamation runoff and sediment control measures are described below and are depicted on Plate IV-B, the Reclamation Treatments Map.

5.9.1 Drainage Plan

The post-reclamation surface water drainage plan will differ slightly from the operational water management plan. Main variances will include restoring water drainage to the natural channels by removing all road culverts, placing waterbars on the roads to prevent road runoff, and allowing precipitation water that falls onto the reclaimed leach pads to drain into nearby drainage channels. In addition, Impoundment M, which was created by waste dumps, will continue to be used as permanent impoundment following reclamation.

Upon project completion, all haul roads will be ripped to permit the infiltration of water through the road surface. At this time, all culverts will be removed and channels restored to their natural course. Newly created slopes adjacent to areas of culvert removal will be regraded to slopes of less than angle of repose to the extent possible. Slopes in the vicinity of culvert removal that are 2h:1v or less will be ripped, topsoiled, and revegetated using the appropriate seed mix. Water bars will then be installed, at the spacing listed below, to divert runoff water from the road surface to the roadside fill slopes to reduce erosion (Plate VI-A and IV-B).

<u>Road Grade (percent)</u>	<u>Spacing (feet)</u>
10 to 14	200 to 100
6 to 10	300 to 200
4 to 6	400 to 300
less than 4	as needed

In addition, the road outslopes that have not been previously hydroseeded with some degree of success will be roughened to the extent possible using equipment which can safely access the outslopes from existing roadways. The effectiveness of various tackifiers will be evaluated for use in seed stabilization on both cut and fill slopes of haul roads. The results of this evaluation will be used to determine the tackifier(s) to be used in conjunction with further hydroseeding. In addition, the appropriate seed mix will be re-applied to those road and fill outslopes that have not been successfully revegetated by past hydroseeding efforts.

The ditches that border the leach pads will be covered during regrading to allow the

free flow of water from the leach pads to drain to an existing natural channel.

The mine dumps will be ripped and revegetated to control runoff velocities across the dump surfaces. All precipitation water falling on the dump surface will seep into the dump surfaces or drain back toward the natural hillside. Precipitation water falling on the dump fill slopes will drain toward the dump toe over the ripped and revegetated dump surfaces.

Runoff from upgradient watersheds will no longer be routed into the NBCS and Melco pits at mine closure. Due to waste dump 6400 near the Barneys Canyon pit, Impoundment M will be 50.7 acre-feet. Therefore, this impoundment has the capacity to contain runoff from events three times that of the 100-year runoff event. Water impounded behind this structure will be released via infiltration and evaporation. Infiltration will provide recharge to the underlying aquifer.

~~Runoff from the watershed upgradient of the BC South dump will drain into the North BC South Pit. The Melco, Barneys and East Barneys pits will North BC South, and South BC South pits will also remain following reclamation. Water impounded in the pits will be released via infiltration and evaporation. Infiltration will provide recharge to the underlying aquifer.~~

Kennecott will examine techniques that may be implemented for the revegetation of the cut and fill-slopes of the Melco haul roads. In general, the following are proposed: 1) all road surfaces will be deeply ripped with a dozer/ripper and topsoil will be placed on the road surface in a roughened condition prior to hydroseeding; 2) all road outslopes that have not previously been hydroseeded with some relative degree of success will be roughened to the extent possible using equipment which can safely access the outslopes from existing roadways; 3) the effectiveness of tackifiers will be evaluated for use in seed stabilization on both cut and fill slopes and, if found to be effective, the appropriate tackifier will be used in conjunction with further hydroseeding; 4) a reapplication of the appropriate seed mix will be applied by hydroseeder to all previously hydroseeded cut and fill slopes that have not been successfully revegetated by past revegetative efforts; 5) culverts and roadfill at drainage crossings will be removed in accordance with the original NOI; 6) newly created slopes adjacent to areas of culvert removal will be regraded to slopes of less than angle of repose to the extent possible; 7) slopes in the vicinity of culvert removal that are 2h:1v or less will be ripped, topsoiled, and revegetated using the appropriate seed mix.

5.9.2 Sediment Control Structures

Reclamation sediment control procedures will be implemented so that soil conservation measures will require little maintenance and will lead to natural long term sediment control. One of the most effective forms of sheet wash sediment control will be the reestablishment of vegetation over the disturbed areas. The establishment of vegetation and reduction of effective runoff length using water bars on the reclaimed haul roads will be the most significant forms of sediment control over the site. Sediment control structures described in Section 3.12.3 and shown on Plate II-B will be retained and

maintained following reclamation to the extent that reclamation regrading will allow. Sediment control structures to remain in place are shown on Plate IV-B. These sediment structures will be removed at the time of reclamation bond release and the sites of the structures will be revegetated using the seed mix shown in Table 5.6-1. Any sediment loads originating from the watershed upgradient of impoundments created by the Melco and BC South pits will be deposited in these impoundments. Sediment loads from pit walls will be retained in pit impoundments. The capacity of these impoundments will be in excess of the potential volume of sediment to be released from the upgradient areas.

The existing impoundments created by the B&G railroad grade will remain after reclamation and continue to function as sediment control structures.

6.0 APPROVED VARIANCE REQUESTS

As the result of natural terrain conditions, the planned location of mine dumps, the proposed final outslope angle of certain dumps, and the planned post-mining use of the open pits, a number of variances from the Division's rule R613-004-112, Reclamation Practices, have been ~~were~~ approved in 1997 and earlier. These variances are presented below in order of the listing of sub-parts of the rule in the regulations.

Kennecott requested variances from Rule R613-004-111.6, Slopes, R613-004-111.7, Highwalls, Rule R613-004-111.12, Topsoil Redistribution, and Rule R613-004-111.13, Revegetation. Likewise, Kennecott has an approved variance from regrading of the lower Melco dump outslopes.

6.1 Variance from Rule R613-004-111.9 Dams and Impoundments

Kennecott will leave in place upon reclamation, Impoundment M created by the 6400 mine dump at the Barney's Canyon site. This facility is part of the overall plan for site sediment control and its exceeds the runoff volume predicted for the 100-year, 24-hour precipitation event. In fact, as discussed in Section 3.12, Impoundment M and the Melco impoundment will have the capacity to store four times the volume of runoff predicted to result from the 100-year event. In addition, the fill will be constructed of porous waste rock and will not be designed to permanently impound water, hence the actual amount of water retained in the impoundments is anticipated to be much less than the predicted volume from any given storm. Approval for installation of these two impounding structures will be sought from the Utah State Engineer in the Division of Water Rights.

6.2 Variance from Rule R612-004-111.6 Slopes

Kennecott requested that a variance from this rule be granted for regrading of the outslopes of the Melco 7200 and 7300 waste rock dumps. A variance from this rule has been approved because regrading would result in substantial additional disturbed area and in an adverse impact to the ephemeral channel in Dry Fork. This affected area is valuable wildlife habitat which further justifies the variance. In addition, the steep slope on which the 7300 dump is sited has a natural slope of approximately 1.75:1 beneath the footprint of the proposed dump and the slope below the proposed dump's toe is even steeper, locally approaching the angle of repose for the waste rock material. Therefore, regrading of this waste rock dump is not possible given the steep terrain upon which it is sited.

The Melco 7200 dump is designed such that the shorter north slope can be regraded and Kennecott has committed to doing so, as described in Section 5.3.2. Kennecott has been granted a variance for the south slope of the 7200 dump. Regrading of this outslope to 2h:1v would result in the regraded waste material reaching the main fork of Dry Fork below. In addition, regrading this dump to a slope of 2h:1v will require double handling of the waste because it is not possible to accomplish regrading in a single slot dozing

operation. Five million tons of waste rock would have to be moved in at least two stages requiring the handling of at least 10 million tons of waste rock at a cost that would be at least twice that of a standard slot dozing operation. In consideration of both the financial impact and the impact to the disturbance of the downslope area, Kennecott has been granted a variance from this rule to cover the Melco 7200 and 7300 dumps.

6.3 Variance from Rule R613-004-111.7 Highwalls

~~In addition to a variance for slope angles, Kennecott has also been granted variances for topsoil application and revegetation.~~

The lower portions of the Barneys Canyon, Melco and North BC South pits will be below local grade which will allow them to serve as sediment retention basins thereby preventing the release of sediment eroded from the pit walls.

These pits may serve as a benefit to wildlife by providing a watering site through collection of runoff from the pit walls.

A variance from this rule which requires that highwalls be "... stabilized...to a slope of 45 degrees or less" has been granted for the Barneys Canyon, North BC South and Melco highwalls and for the slopes of the South BC South pit that will remain following backfilling. Maximum overall pit angles at Melco and North BC South are expected to be 47 degrees, while at South BC South, the maximum overall pit angle is planned to be 39 degrees.

Reduction of inter-bench slope angles by modification of mine plans to as low as 45 degrees would require either a major reduction in the quantity of ore mined, a substantial increase in the amount of waste mined, or a reduction in the overall grade of ore mined. Any of these alternatives would have an unacceptable impact on the economic viability of the project and may significantly increase the disturbed area.

All of the open pits at Barneys Canyon would be excavated in bedrock; hence, conventional concepts of angles of repose and stability of unconsolidated materials would not apply. These pits must meet the stability requirements of the Mine Safety and Health Administration (MSHA). Because pits must be excavated in a manner that assures pit wall stability during mining, the pits as currently designed are inherently more stable than a pit that has been reclaimed to 45 degrees by placement of unconsolidated materials against bench slopes.

Reduction of inter-bench angles to 45 degrees through regrading is generally not possible for the following reasons:

- 1) The angle of repose of waste rock materials is substantially less than 45 degrees; hence it is not practicable to regrade to such a standard.
- 2) Regrading of individual benches to 45 degrees or less at Melco would not be possible because the overall pit slope is greater than 45 degrees.

3) Individual benches will be inaccessible following completion of the mining operations; therefore, placement of fill material along benches would not be possible.

4) Regrading of slopes from the pit margins would be an unsafe work practice since equipment would be required to work on slopes that would be no less steep than the angle of repose.

Kennecott has committed to partially backfilling the South BC South pit with waste from the North BC South pit. The approximate backfilled configuration is shown on Plate IV-B. Kennecott has been granted a variance from this rule for further regrading of the highwalls that will remain following regrading, as shown on Plate IV-B. Backfilling of the Melco pit and the North BC South pit would require double-handling of waste rock or excessive haul distances from other open pits, resulting in an unacceptable increase in overall mining costs. In addition, currently uneconomic mineralization will remain in the North BC South deposit following completion of the planned mining operation. Backfilling this pit would render the mining of this reserve impossible in the event of improved economic conditions. For both reasons stated above, a variance from this rule has been granted for both the Melco and North BC South open pits.

6.4 Variance from Rule R613-004-111.2 Drainages

For the reasons discussed above in Section 6.1, Kennecott has been granted a variance from this rule to enable Impoundment M to remain following reclamation.

6.5 Variance from Rule R613-004-111.12 and 111.13 Topsoil Distribution and Revegetation

Kennecott has an approved variance from topsoil placement and revegetation at the Melco pit. Kennecott has committed to topsoiling open pit floors and benches that are safely accessible following completion of mining, including the Melco pit. It is not anticipated that any of the benches at Melco will be accessible, however. Kennecott has also been granted a partial variance from topsoil placement and revegetation in the BC South pits. Topsoil placement on most pit benches is not possible because benches will not generally be accessible either during mining, for reasons of safety, or following completion of mining due to isolation of individual benches as pits are advanced. However, those benches more than 40 feet wide that are safely accessible will be topsoiled and revegetated. Revegetation of the un-topsoiled parts of the disturbed pit areas, which are excavated in bedrock, is not possible.

Kennecott has also been granted a variance from Rule 111.13.11, which requires that revegetative cover achieve 70 percent of the pre-mining vegetative cover. This variance has been granted for all surfaces that are not covered with topsoil as part of reclamation, including open pit walls, road fill outslopes, roadcuts, and the outslopes of the Melco 7200 and 7300 waste rock dumps. A similar variance from this revegetation standard had been

granted in the original NOI. Kennecott agrees to work with the Division to develop an alternate numerical revegetation success standard for the angle of repose waste dump and haul road out slopes and haul road cut slopes. This standard would be developed by evaluating the relative success of past hydroseeding efforts, evaluating natural vegetative cover in undisturbed areas that have similar elevation and slope aspect, and by using whatever information the current literature may provide. In addition, the 7300 dump out slopes revegetation program will be initiated as soon as practicable following completion of dump construction. The experience gained from this effort will be applied to reclamation of the 7200 dump and may be used to revise the numerical revegetation standard for the angle of repose slopes.

6.6 1997 Request for Variance From Rule R647-004-111.9

In 1997 Kennecott Barneys Canyon Mining Company requested a variance for R647-4-111.9 Dams and Impoundments for the East Barneys Pit, based on the following information;

- 1) The pit will be a permanent, stable feature on the landscape because it will be excavated below grade in rock.
- 2) Water impounding in the pit will only be a temporary feature after periods of high precipitation and/or surface water runoff in Barneys Canyon. This impounded water is expected to drain naturally by infiltration into the oxide rock of the pit bottom and by evaporation.
- 3) Temporary water storage in the pit bottom should not produce a hazard to human health and will be a drinking water source of local wildlife.
- 4) There are no feasible, alternate methods to be utilized because there are no plans to backfill or otherwise grade the East Barneys pit to eliminate its impounding nature. Such grading would cause additional land disturbance in addition to the pit itself.

6.7 1997 Request for Variance From Rule R613-004-111.7

In 1997 Kennecott Barneys Canyon Mining Company requested a variance for rule R647-4-111.7 limiting high wall slope angles for the East Barneys Pit.

- 1) Reduction of inter-bench slope angles by modification of mine plans to as low as 65° would require either major reduction in quantity of ore mined, a substantial increase in the amount of waste mined, or a reduction in the overall grade of ore mined. Any of these alternatives would have an unacceptable impact on the economic viability of the project and may significantly increase the disturbed area.
- 2) Because pits must be excavated in a manner that assures pit wall stability

during mining. The pit is inherently more stable than a pit that has been reclaimed to 45° by placement of unconsolidated materials against bench slopes.

7.0 RECLAMATION COST ESTIMATE

Revegetation test plot results have indicated that the previous topsoil requirement of 12" can be successfully reduced and still achieve the specified vegetation standard required for final reclamation. This change in topsoil requirement significantly reduces final reclamation costs from previous estimates. This recent cost estimation is based on placement of six inches of topsoil in all areas except for the sulfide repository caps and those areas identified for hydroseeding or special treatment (see Plate 96-1 for details). Please see Appendices H-1 and H-2 for a detailed cost accounting. The change in design of the sulfide repository caps has also significantly reduced the total reclamation cost.

Currently permitted area requiring reclamation	=	961 acres
Expansion area requiring reclamation	=	134 acres

Total project area currently requiring reclamation = 1,095 1187 acres

The total revised reclamation cost is:

$(1,095 \text{ } 1187 \text{ acres}) * (\$3,325 \text{ per acre}) = \$3,640,615 \text{ } 4,282,600$ (in 2001 dollars)

The existing reclamation bond is \$4,604,000.

Although the current bond is almost 1 million more than 300,000 dollars above the projected cost, no decrease in the surety is being requested as part of this amendment.

8.0 REFERENCES

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JBR Consultants Group, 1988, Notice of Intent to Commence Mining Operations, Kennecott Explorations (Australia) Ltd., Barneys Canyon Project, Submitted to Utah Division of Oil Gas and Mining (Revised, September, 1989)

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Soil Conservation Service, 1972, National Engineering Handbook NEH-4 Hydrology, Washington, D.C.

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This page is a reference page used to track documents internally for the Division of Oil, Gas and Mining

Mine Permit Number MD350009 Mine Name Barneys Canyon
Operator Kenneth Barneys CYN Date June 7, 2001
TO _____ FROM _____

☐ CONFIDENTIAL ☐ BOND CLOSURE ☐ LARGE MAPS ☒ EXPANDABLE
☐ MULTIPUL DOCUMENT TRACKING SHEET ☐ NEW APPROVED NOI
☐ AMENDMENT ☐ OTHER _____

Description

YEAR-Record Number

☐ NOI ☒ Incoming ☐ Outgoing ☐ Internal ☐ Superceded

Redline Copy of Revised Barneys
Canyon Reclamation Plan

☐ NOI ☐ Incoming ☐ Outgoing ☐ Internal ☐ Superceded

☐ NOI ☐ Incoming ☐ Outgoing ☐ Internal ☐ Superceded

☐ NOI ☐ Incoming ☐ Outgoing ☐ Internal ☐ Superceded

☐ TEXT/ 8 1/2 X 11 MAP PAGES ☐ 11 X 17 MAPS ☐ LARGE MAP

COMMENTS: _____

CC: _____